THURSDAY, SEPTEMBER 6, 1894.

A NEO-LAMARCKIAN THEORY OF EVOLUTION.

A Theory of Development and Heredity. By Henry B. Orr, Ph.D., Professor at the Tulane University of Louisiana. (New York and London: Macmillan and Co., 1893.)

THE appearance of a new work on the causes of evolution, by an American biologist, raised the hope that more solid arguments would be forthcoming in favour of the conclusions accepted by so many well-known writers and workers on the other side of the Atlantic. This hope was doomed to disappointment, the evidence adduced being even more slender than usual, and the conclusions even more rash.

According to a view which has been recently put forward by Lamarckian writers, the facts of adaptation are explained by the supposition that organisms possess such a constitution that they are compelled, by the incidence of external forces, to react adaptively, viz. by the production of useful variations. This view appears to be supported by the author (chapter i.), although no evidence is brought forward in favour of it. The hypothesis in question seems to be little more than the old "internal developmental force," or "innate tendency towards perfection," in a modern dress. Furthermore, a little consideration of the essential nature of adaptations proves the futility of any such attempt at explanation. The ultimate objects of adaptations are to obtain food, to escape enemies, or to subserve reproduction. In the vast majority of cases adaptations are relative to the condition of other individuals of the same and other species —a condition which is and has been continually changing. But the environment with which the organism is in continual contact, and which is presumably supposed to bear a pre-eminent part in working these useful variations, is the inorganic environment. So that stimuli provided by one form of environment are looked upon as the direct causes of adaptations which are essentially related to another and very different environment. It would be necessary, in order to make the suggestion valid, to prove that the changes in the organic environment which render some adjustment of adaptation necessary, are invariably accompanied by corresponding changes in those forces (chiefly inorganic) by which it is believed that the adjustment is effected.

In discussing "the limits of natural selection," the following supposition is believed to constitute an insuperable objection to Weismann's theory of heredity, viz. "the supposition that the germ-plasm may exist in the body and still be no more affected by the changes which pass over the body than if it were enclosed in an hermetically sealed vial." It is well known that in all his later writings Weismann has abandoned the hypothesis of a germ-plasm endowed with an almost resistless stability. But the admission of the converse supposition, that the germ-plasm is profoundly affected by the external forces which also affect the body, is very far from the admission that acquired characters are transmitted; and it is this latter, and nothing less, which is required as a foundation for the Lamarckian hypotheses, as, indeed, the author freely admits. In order to prove that the one proposition involves the other, it would be necessary to show that an external force producing a certain effect on the body must produce, upon a totally different thing—the germ-plasm—not, indeed, the same effect, but its precursor.

Considering "the many cases of wholesale destruction of animals—for instance, the killing of countless fishes by a sudden change in the temperature of the ocean, the killing of birds and insects by cold and storms of wind and rain, and the killing of myriads of organisms of all kinds by circumstances over which they have no control, and from which no mere individual variations could save them," the author is led "to doubt that natural selection acts with such mathematical accuracy in accumulating slight individual variations." It is difficult to understand the grounds upon which the non-operation of natural selection in certain kinds of destruction is held to cast doubts upon the efficiency of its action when it does come into operation. Furthermore, it is easy to point to results which are consistent with the view that natural selection may act "with mathematical accuracy" even in the class of cases brought forward. The peculiar condition of the wings of insects living in islands in stormy zones, and a power of resisting temperature related to the needs which follow from the geographical distribution of plants and animals, may be cited as examples.

The author quotes with approval Prof. Cope's contention that "the useful additions which have constituted certain genera, families, orders, &c., what they are," were produced as a direct consequence of needs, and were not formed first and selected afterwards, inasmuch as "it would be incredible that a blind or undirected variation should not fail, in a vast majority of instances, to produce a single case of the beautiful adaptation to means and ends which we see so abundantly around us. The amount of attempt, failure, and consequent destruction would be preposterously large, and in nowise consistent with the facts of teleology as we behold them."

This antithesis suggests that it is believed that "the useful additions" were fully formed as complete organs or parts before they were selected. According to the theory of natural selection, however, such "additions" have been led by selection from the very first—from the time when the parent organ or part first began to be used for a new purpose (for such is almost invariably the origin of the last "addition")—right back to the remote period when the original ancestor of a long succession of organs and parts came into being. But even accepting Prof. Cope's antithesis, surely, when we consider the slow succession of forms throughout geological time, and the amount of extinction which took place in every generation, we may accept his conclusion as to the amount of "attempt, failure, and consequent destruction," and reply that on this very account the Lamarckian explanation is extremely improbable, inasmuch as it would imply a direct and rapid evolution, whereas we know that evolution has been slow and interrupted.

Unnecessary confusion has been introduced into the discussion of instincts by the inclusion under this term

of the clearest results of education and experience, containing nothing in common with true instinctive actions. Thus we read on p. 21:—"That the Kea-bird of New Zealand has learned to dig the kidney-fat out of living sheep since the introduction of sheep into that country, is another wonderful instance of change of instinct hardly to be accounted for by means of natural selection, but rather as the result of intelligent experience."

Speaking of instinct, he maintains "this seems to be a well-defined case of the inheritance of acquired characters. We cannot deny that the idea or knowledge has been acquired, neither can we deny that it has been inherited." And yet many instinctive actions of the greatest complexity and interest take place under conditions which preclude the possibility of the acquisition of any idea or knowledge. Thus many insects before pupation take the most elaborate precautions, which tend to prevent their detection by enemies they have never seen and never will see in the helpless stage they are about to enter. If knowledge cannot have had any part in the origin of such marvellous instincts, it is unnecessary to suppose that it is an element in the rise of any truly instinctive action.

In considering the source of organic energy in chapter ii., the author supposes that by the law of conservation of energy all the forces of the environment which act upon an organism must be transferred into some form of energy within it, accounting for "all changes in shape and all changes in the method of activity." In order to help to understand how this may occur, he instances a number of photochemical changes taking place in inorganic bodies. But the law of conservation of energy demands nothing of the kind. The forces which fall upon the organism must indeed persist, but not necessarily in any form which can be made use of by the organism; or they may, and indeed frequently do, serve to expend part of the store of potential energy derived by the organism from other forces. Thus the effect of any external force (*e.g.* light, heat, sound, &c.) upon a peripheral end organ is only conveyed to the brain by the expenditure of potential energy derived from food. The animal may benefit by the information received, but the transmission itself is a loss, and not a gain to the store of force at its disposal.

When, in chapter iii., the author considers in further detail the action of environing forces, many instances are brought forward, in which it is clear that some *necessary condition* of development, such as food or heat, is interpreted as a *cause* of development. It is surprising that the author did not think of applying his conclusion that "food is one of the stimulating forces which guide and determine the developmental reactions of the organism" to the vegetable world; where an endless variety of forms depend upon a food supply which is, when compared with that of animals, remarkably uniform.

The naïve manner in which conclusions are drawn is surprising in an author who is evidently a trained biologist, and is accustomed to the indirect and excessively complex relation of causes to effects met with in organic nature. Thus, on p. 47 we are told that "pigment increases in quantity or brilliancy as we approach the equator, where the light is most intense. There is thus a direct ratio between the amount of light and amount of pigment"; and again on p. 49: "The plain facts lead to the conclusion that pigment is caused by light acting upon the tissues, and where there is no light there can be no pigment." It is interesting to compare these bald statements with the evidence produced by Dr. A. R. Wallace, that there is no proportionate increase in quantity or brilliancy of colour—either animal or vegetable—in tropical as compared with temperate countries; but that such increase as there is, is merely proportionate to the increase in variety and number of forms of life. But apart from this deliberate conviction of one whose opinion on such a subject is entitled to so much consideration, the mode of development of pigment in animals is entirely opposed to the author's conclusions. The bright colours of insect-imagines are developed in an earlier stage, during which they are comparatively screened from light, and when in the final stage the colours are exposed, they undergo no change in the direction of increasing brilliancy. Even such changes as the darkening of the freshly exposed pupal cuticle—long assumed to be photochemical—have been shown by the writer to be independent of light, and almost certainly due to oxidation.

Equally rash and ill-considered is the conclusion, in the same chapter, that the colours of desert animals and of those living among the sea-weed of the Gulf Stream are due to a direct photochemical influence of the respective environments, and that the whiteness of Arctic animals "may be primarily due to the small amount of light in those regions." In reaching this last conclusion the author relies upon the supposed fact that *all* classes of animals are similarly coloured, forgetting that when, as in the raven &c., a white appearance is not needed for attack or defence, it is not attained.

In considering the action of the nervous system, in chapter iv., it is "safely" concluded that "the energy of the forces, acting from without, persists within the living matter as nervous activity and change of nervous condition." It has been already pointed out that such persistence is frequently attended by a loss rather than a gain to the energy at the command of the organism. The author has thought it worth while to translate long passages from Detmer, and does not appear to be aware that the conclusions he quotes have been refuted by Weismann, and are even rejected by botanists who do not agree with the views of the latter.

In chapter v. it is contended that development has been dependent on association and repetition. It is forgotten that many essential actions are performed but once in the life of the individual (*e.g.* cocoon-spinning), or are as perfectly performed the first time as on subsequent occasions (*e.g.* web-spinning of spiders, sucking of mammals). The author freely admits that such a theory of development demands the transmission of acquired characters, and it is therefore remarkable that his discussion in chapter vii. of this question—the foundation of every conclusion he brings forward—should be so brief, and his reasons for accepting such transmission so unconvincing.

In chapter ix. the author attempts to illustrate in the

approved Neo-Lamarckian manner the moulding of limbs and the skeleton generally as the result of the forces to which they are exposed during the life of the individual. In the explanation of the remarkable lengthening of the fore-part of the giraffe we meet with a suggestion which is, I believe, new in the history of Lamarckian speculation. In stretching for food it is contended that the animal "must have constantly raised itself off its fore-feet, and as it dropped must have received a shock that made itself felt from the hoofs through the legs and vertical neck to the head. In the hind-legs the shock would not be felt. . . . The principle of increased growth in the direction of the shock resulting from superabundant repair of the momentary compression, explains how the giraffe acquired the phenomenal length of the bones of its fore-leg and neck; and the absence of the shock in the hind-quarters shows why they remained undeveloped and absurdly disproportionate to the rest of the body." (pp. 164–165.) It is unnecessary to take the trouble to refute the details of the various suggestions brought forward by the upholders of the Lamarckian hypothesis: they refute each other. One of them explains a lengthened neck as the result of extension, another as the result of compression; while neither give any approach to a proof that such an effect is likely to result from the antagonistic forces which they respectively invoke.

E. B. P.

CELESTIAL PHOTOGRAPHS.

A Selection of Photographs of Stars, Star Clusters and Nebulæ, together with information concerning the Instruments and the Methods employed in the Pursuit of Celestial Photography. By Isaac Roberts, D.Sc., F.R.S., &c. (London: The Universal Press, 1894.)

THIS handsome collection of celestial photographs is a remarkable example of what can be done single-handed in a new line of research. Taking up celestial photography more than ten years ago, Dr. Roberts has devoted himself entirely to it, and has been rewarded with an amount of success that must be to him a source of intense satisfaction.

This success, however, has not been obtained by merely exposing plates in the telescope and watching the images come out in the developing dish. The work that Dr. Roberts set himself to do was planned at the outset in a thorough manner, and has been carried out apparently without regard to either labour or expense; even to the extent of the removal of the observatory near Liverpool, to a better position, selected after a most exhaustive discussion of weather conditions in the south of England.

In the introduction of his book Dr. Roberts tells us that a reflector of twenty inches aperture was the instrument decided upon, in consultation with Sir Howard Grubb, as the most ikely to give the best results. An instrument of this size, arranged for exposing the plate without the use of a plane or prism, was made and mounted by Sir Howard Grubb in 1885. With this instrument all the celestial photographs have been taken.

The first arrangements do not appear to have been quite satisfactory, so that the telescope had in great part to be reconstructed; but even then the star images were found, on trial, to be elongated, though this defect seems to have been remedied later on, if one may judge by the remarkable absence of any deformation of image in some of the very long exposure photographs.

The question of the utility of the photographic chart is discussed, and the fact mentioned that Dr. Roberts had already, in 1885, begun a photographic chart of the northern heavens, and made some progress, when the International Congress for the Photographic Chart of the Heavens took up this work. The use of the paper copies of celestial photographs might, it is suggested, be (1) the detection of changes in the structure of nebulæ; (2) the detection, on a large scale, of movements amongst the stars; (3) determinations of variations in stellar magnitudes; (4) relative distribution of stars in space; (5) detection of new stars and disappearance of others.

In cases, however, where measurements to a second of arc are required to be made, then the original negatives must be used for the purpose; and in this we quite agree with Dr. Roberts. It would have been well worth while to picture, in this connection, the instance given by Dr. Roberts of his comparison of a chart of the heavens, made in 1863 by D'Arrest, showing 212 stars, with a photograph of the same region taken in 1890, which showed that considerable changes had taken place among the stars in this small area of the sky (comprised within one degree of declination and half a degree of right ascension) during the interval of twenty-six years between the epochs of the charts.

The relative advantages of refractors and reflectors as photo-instruments, and the requirements and adjustments of a reflector for celestial photography are discussed; and the ideal instrument for photographing the sun, moon, and planets is given as a refractor of six or eight inches aperture and very great focal length; but for the delineation of faint stars and faint nebulosity, Dr. Roberts gives a preference to the silver-on-glass reflector, and he would choose an instrument of twenty-seven inches clear aperture and eleven feet three inches focal length, the mirror being figured, and every part of the mechanism made in the most perfect manner possible, and with a guiding telescope with an objective ten inches in aperture. To anyone contemplating the erection of an instrument for celestial photography, these hints—the results of many years' experience—should be of great value.

The other chapters, on the collimation of the mirror, the essentials of a photo-telescope, method of testing the stability of a photo-instrument, and photographic plates, their exposures and developments, will be read with great interest by all photo-astronomers.

The chapter on the collimation of the mirror gives an account of the method employed to check the guiding telescope, and is perhaps the only point on which something might be said in the way of criticism of Dr. Roberts' method. It is difficult to see why the method described should not be varied so as to be always available, and so dispense with the guiding telescope; a matter of no slight importance in the case of such an instrument as Dr. Roberts has suggested, the ten-inch objective of which would cost as much or more than the mirror. We

believe Sir Howard Grubb has already suggested some such method.

We should have very much liked further information about the instrument, the supports of the mirror and the plate-holder, and other details, but these are perhaps rather in the province of the telescope-maker than the photo-astronomer. A photograph of the double telescope, however, gives a very good idea of the general arrangements, and there is also a photograph of the observatory.

Of the forty-nine celestial objects reproduced on paper, four are star charts, twenty-two are clusters of stars, and twenty-three are nebulæ. The earlier and most important photographs in this collection have already been published in various ways, and many of the others exhibited at the meetings of the Royal Astronomical Society; for Dr. Roberts, with proper scientific spirit, has always been ready to place any of them at the disposal of astronomers; but they lose nothing of their great interest by being seen in the collected form.

Had Dr. Roberts' work been only to produce the first photograph, that of the great nebula in Andromeda, and had that been the only result of all his labour, he would have been amply repaid, for it is certainly not too much to say that, in this picture, photography has done more to justify its use by the astronomer than in any other case; and one can feel that the hopes that were formed by Rutherford and others in the early days of photography, and which lay dormant for so many years, have now been realised. The perfection of delineation enables the true character of this marvellous object, which remained hidden from the closest scrutiny of such a careful and competent investigator as G. P. Bond, to be at once seen and appreciated. It is difficult to imagine that such an enormous object as the Andromeda nebula must be, is not very near to us; perhaps it may be found to be the nearest celestial object of all beyond the Solar System. It is one that offers the best chance of the detection of parallax, as it seems to be projected on a crowd of stars, and there are well-defined points that might be taken as fiducial points for measurement. Apart from the great promise this nebula thus seems to give of determining parallax, there is a fair presumption that in course of time the rotation of the outer portion may perhaps be detected by observation of the positions of the two outer detached portions in relation to the neighbouring stars.

The photographs are arranged in order of right ascension, each has its position given, and many have marked fiducial stars whose position is given for 1900. The scale of enlargement is also given, so that with the help of a table of corrections of errors due to the slight alterations in scale in enlarging or printing, any point on the photograph can be determined with an accuracy sufficient at least for purposes of identification.

For some purposes, no doubt, it will be absolutely essential to have recourse to the original negatives, but, as Dr. Roberts has pointed out, there are many purposes for which these paper copies are available. In addition to the full date of each object, which is admirably done, there are various useful references to previous observations. The accuracy with which the telescope is kept pointed during a long exposure is seen by a glance at the shape of the brighter star images, as a shift, if not at once corrected, produces deformation. In nearly every photograph the stars are round, in some they seem absolutely so, which shows the perfection of the instrumental arrangements of Sir Howard Grubb, and the care with which the exposures have been made. Some of the star photographs—as, for instance, plate 43—show a perfection of image and an absence of distortion over a large field that is very satisfactory. A comparison with a plate of the same region taken by an International Chart refractor would be interesting.

In looking at the examples of spiral nebulæ, of which there are several, one cannot help thinking of Lord Rosse, and the correctness with which he delineated these objects, though his views at the time were not generally accepted by astronomers. These most interesting nebulæ will repay further study, perhaps, more than any other.

Some of the cluster photographs are too much enlarged for the ordinary distance at which one reads a book, but the proper effect can be obtained by looking at them about three feet away. All the photographs are about as good as it is possible to take with an instrument of the size used by Dr. Roberts, and the present dry plates; better photographs can only be obtained by the use of a larger telescope, or by means of dry plates that will, with the same or greater sensitiveness, give a finer grain. This is shown by a comparison of the photograph of the cluster M. 5, taken by Dr. Roberts, with one taken with a larger telescope of a similar kind. Dr. Roberts states (p. 91) that "the cluster is enclosed in dense nebulosity about the centre, the nebulosity hides the stars, even on the negative"; but an inspection of the photographs by a larger instrument shows that the stars are quite distinct, though the exposure was very much longer, a result that might fairly be expected.

A comparison of photographs of this object, taken at different dates, shows that many of the stars of this cluster are variables, and of course it is just possible that there may be variability in the central portions.

Excellent as are the paper reproductions of these photographs, they cannot give all the beautiful detail to be seen on the original negative of a nebula. If change be taking place, it is more than likely that it may be seen in the finer detail first, in which case the original negative must be seen. This points to the absolute necessity of preserving the negative where it shall be available in after years. We hope that all valuable originals will find their way eventually to the keeping of the Royal Astronomical Society, which now undertakes this important duty.

This volume shows that Dr. Roberts has spared neither himself nor his purse in fulfilling the task he set himself to do, more than ten years ago. By the great labour and devotion he has shown for many years in carrying out his carefully considered plans, he has set a model for others to follow in taking up a research of this kind, of which there are so many in astronomy, that from the nature of the case can only be well done by those who, like him, undertake it solely as a labour of love.

A. A. COMMON.

DEAF-MUTISM.

Deaf-Mutism. By Holger Mygind, M.D., Copenhagen. (London: F. J. Rebman, 1894.)

A FEW months ago, in noticing "The History of American Schools for the Deaf," we spoke of the treatment of deaf-mutes, and regretted the fact that we hear so little of that work in England. Before us we have another book, again of foreign origin, in which is described, exhaustively and systematically, the pathology of deaf-mutism. The materials used in its compilation are almost entirely obtained from Denmark, and, although published in England, and revised by an English specialist of note, the book may be said to have a somewhat foreign flavour. With the exception of special chapters upon the subject in Wilde's, Field's, and Toynbee's works on diseases of the ear, little is to be found in English writings, and there are no books dealing solely with deaf-mutism written by Englishmen. This may, perhaps, be accounted for by the fact that in the table of recent statistics of the distribution of deaf-mutes in various countries, England and Wales stand twentieth in a list of twenty-three, showing only fifty-one of these unfortunates per thousand inhabitants. Ireland and Scotland stand higher in the table, with seventy-seven and fifty-seven per thousand respectively. Still, even with the happily low rate of deaf-mutism in this country, it is a matter for regret that no Englishman has produced a work upon the subject.

Dr. Holger Mygind performs his task very well. To begin with, he arranges it in a systematic manner, and treats each part as exhaustively as lies in his power. Devoting his introduction to definition, literature, classification, and distribution, he gives evidence of considerable patient research. In discarding the classification of deaf-mutes according to the degree of its symptoms for that according to its etiology, he does wisely, the former being as unscientific as it is misleading. It is a pity that "Creed" should have been included under the heading "Distribution," since Dr. Mygind shows that the apparent greater frequency among certain religions is, as one would expect, really due to the relative numbers of persons professing such religions; while the well-known fact that the Jews produce a larger number of blind, idiotic, and deaf-mute individuals than the races among which they live, is due, doubtless, to the consanguineous marriages practised by the Hebrews.

Perhaps the most interesting part of the work (the whole of which cannot be otherwise to the student of pathology) is the chapter which deals with etiology and pathogenesis, and in which such conditions as climate, water, hygiene, heredity, and the like are discussed. With regard to heredity, Dr. Mygind brings forward a series of facts (the collection of which must have caused considerable labour) referring to the appearance of deaf-mutism and other pathological conditions among the relatives of deaf-mutes, and from these facts endeavours to formulate some definite laws concerning the heredity of deaf-mutism. These laws, it is stated, are difficult of interpretation, and seem in many respects to differ from those which relate to other pathological conditions and diseases, a fact to be accounted for by the number and variety of the causes of deaf-mutism, and consequently of the causes of each individual case. The matter is further complicated by the presence of factors, equally important, which tend to neutralise the transmission of morbid tendencies. It appears that deaf-mutism is, in many instances, the combined result of the transmission of various influences which fall into two groups—those which originate in ear diseases, and those which originate in nervous diseases in the family.

The material from which the chapter on morbid anatomy is based is formed from the reports of some 139 autopsies, the principal of which are collected in an appendix. The morbid changes in the ear are classified under the heads of external ear, middle ear, and labyrinth. From the evidence here collected, it seems that the pathological conditions differ rather in extent and intensity than in quality from those generally found in ear diseases, and, from appearances alone, it is in many cases impossible to decide whether the changes are of fœtal or post-fœtal origin. Dr. Mygind sums up the question of pathology in these words: "Deaf-mutism is, therefore, from an anatomical point of view, in most cases to be considered as a result of an abnormality of the labyrinth."

We congratulate Dr. Mygind upon the successful completion of a task which must have been at once laborious and interesting. To the pathologist, whether general or special, the work cannot fail to be a source of interest, and it is to be hoped that the work done by the author in thus bringing together so much that is known upon the subject will be productive of good.

P. MACLEOD YEARSLEY.

OUR BOOK SHELF.

A Text-book of Physiological Chemistry. By O. Hammarsten, Professor of Medical and Physiological Chemistry in the University of Upsala. Authorised translation from the second Swedish and from the Author's enlarged and revised German edition, by J. A. Mandel, Assistant to the Chair of Chemistry, Bellevue Hospital Medical College, New York. (New York: John Wiley and Sons, 1893.)

PROF. HAMMARSTEN is so highly esteemed for his work and views on the more specially chemical side of physiology, that a text-book from his pen was looked for with keen anticipation. Unfortunately a knowledge of the Swedish language is not as yet an accomplishment possessed by more than a favoured few, however essential it may become in the future, so that when his text-book first appeared its contents were largely inaccessible to the majority of would-be readers. As a consequence of this, Prof. Hammarsten was asked by numerous colleagues to provide a German version of the first Swedish edition. Unable to comply with this earlier request, he yielded to a strongly renewed similar proposal after the appearance of the second Swedish edition, and in 1890 he published the work in German, translating it himself. In its German dress the text-book is so well known and approved that detailed criticism or renewed commendation is now scarcely necessary. Written "to supply students and physicians with a condensed and as far as possible objective representation of the principal results of physiologico-chemical research, and also with the principal features of physiologico-chemical methods of work," the book was not regarded by its author as "complete or detailed" from the point of view of the specialist. Clear, yet

concise, and dealing not only with the well-known facts and methods of physiological chemistry, but also with the more important points of pathologico-chemical interest, this work is peculiarly suited for the student while going through a course of laboratory instruction. From this point of view the present English version should be widely welcomed. The translation has been made without additions or changes from the author's German edition and the original Swedish. Judged by a comparison with the German, the translator must be congratulated on the way he has done his work. While adhering very closely and literally to the original, the translation reads well and is free from the awkward and often clumsy expressions which frequently result from attempts to render German phrases too closely into English equivalents.

After a short introduction (chapter i.), treating in a general way of some of the more important chemical processes and agents which have to be dealt with in the living body, the next twelve chapters give an account of proteids, the animal cell, blood, chyle, lymph transudations and exudations, the liver, digestion, connective tissues, muscle, brain and nerves, organs of generation, milk, the skin and its secretions. Chapter xiv., the longest and one of the most important in the book, is on urine. Here, from the practical importance of the subject, the treatment is more elaborate than in the preceding chapters, more especially as regards details of analytical methods and urinary analysis. Here also, as in the other chapters, the analytico-chemical parts are distinguished from the rest of the text by special type, an excellent plan which facilitates the work of those who may wish merely to learn what is most definitely known of the substances and processes of the animal body. The last chapter contains a concise but clear account of the more important facts of the exchange of material (Stoffwechsel) or metabolism, and of its relationship to various foods and to the conditions of starvation, exercise, rest, &c. Some useful tables of the composition of various foods are placed at the end of this chapter, and, after the index, which is full and carefully made, a plate is given of the more common and important absorption-spectra.

Electricity, Electrometer, Magnetism and Electrolysis. By G. Chrystal, M.A., LL.D. and W. N. Shaw, M.A., F.R.S. (London: A. and C. Black, 1894.)

THE present cheap reprint of these articles from the Encyclopædia Britannica should meet with a hearty welcome from all students of electricity and magnetism, and more especially from those who are desirous of extending their acquaintance with the science beyond the limits of ordinary elementary text-books. Such students generally find a difficulty in selecting a work from which to read the higher parts of the subject. Maxwell's treatise is too mathematical for the majority of students; one work is, perhaps, too technical in character, while another deals too exclusively with practical measurements. The division of the subject after the first stages into mathematical and technical branches is certainly a natural one, and corresponds in some measure with the requirements of students. It does not, however, lighten the labours of those who wish to obtain a grasp of general theory and experiment without being cumbered with the details of machines on the one hand, or degenerating into pure mathematics on the other. For such students the articles of Prof. Chrystal and Mr. Shaw help to fill a gap left behind by the existing text-books. The historical, experimental, and mathematical portions are nicely balanced, and together form an epitome of the whole subject, which is made more valuable by the addition of references to original papers and standard works. The student will find it both a guide and a key to his reading, and by looking up its references he may pursue the subject to any desired degree of detail.

In the interval which has elapsed since the first publication of the articles, knowledge has been accumulated, and it is a matter for regret that the circumstances of the present issue do not permit of the articles being brought up to date. The absence of all reference to the work of Hertz in electricity, and of Ewing in magnetism, is attributable to this cause; while Mr. Shaw's Reports to the British Association show that much work has been done in connection with electrolysis since his article was written. Similarly in Electro-metallurgy—an article which, by the way, is not specified on the title-page—considerable progress has to be reported.

Apart from these additions, there is one point in Prof. Chrystal's article which might be improved, namely, the definition of the statical unit of electricity (p. 21). It ought to be stated that the force exerted on the conductors carrying the charges is measured *in vacuo.* Indeed, it would be better to introduce the idea of specific inductive capacity at this point, and so avoid a certain amount of confusion between electric induction and electric force in the following pages. The same remarks apply to the unit of magnetism (art. "Magnetism," p. 227). But although it is easy to criticise past writings in the light of present knowledge, we venture to think that the articles before us will stand a far more severe test than many works written at a later date.

JAMES L. HOWARD.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Velocity of the Constantinople Earthquake-Pulsations of July 10, 1894.

ACCORDING to the accounts so far published, it would appear that the epicentrum of this earthquake was situated under the Sea of Marmora, at a short distance from San Stefano; but, for the purpose of this paper, no very sensible error will be introduced by assuming it to coincide with Constantinople itself.

To ascertain the time at the origin, I applied to M. Coumbary, director of the Meteorological Observatory at Constantinople, and to Mr. W. H. Wrench, H.M. Consul-General in that city. M. Coumbary informs me that the first great shock was felt at 12h. 24m. p.m. Constantinople mean time (or 10h. 28m. a.m. Greenwich mean time); its direction was from south-west to north-east, and its duration eight to ten seconds. A second shock, lasting three seconds, followed immediately; and a third, of one second duration, at 12h. 31m. A number of slight shocks succeeded these, but I have received no certain record of them from distant stations. Mr. Wrench kindly made inquiries of several watchmakers in the city. Two regulating clocks were stopped by the principal shock, one at 12h. 20½m., the other at 12h. 21¾m.; both, according to their owners, having previously indicated correct local time.

The earthquake was felt at Bucharest, and it was also registered by a horizontal pendulum at Nicolaiew, and by magnetic instruments at Pola, Potsdam, Wilhelmshaven, Utrecht, Parc Saint-Maur, and Kew. In the following summary the times are reduced to Greenwich mean time:—

Bucharest (Dr. S. C. Hepites).—A very slight shock was felt at 10h. 30m. 11s. a.m., of intensity 3 (Rossi Forel scale), direction from east to west. Two pendulums, placed on north-south walls at the Meteorological Institute, were stopped.

Nicolaiew (Prof. S. Kortazzi).—The curve traced by the horizontal pendulum was suddenly broken at 10h. 30m. 36s. a.m.; the pendulum itself was thrown out of position, and was found afterwards leaning against one of the side-supports.

Pola (Dr. S. Müller).—The declination curve shows two disturbances, at 10h. 36m. 37s. and 10h. 41m. 37s. a.m. The movements indicated on the bifilar and Lloyd's balance curves are very slight.

Potsdam (Dr. Eschenhagen).—First shock at 10h. 34m. 44s. a.m., amplitude ⅓′; second shock at 10h. 36m. 24s., amplitude 9–10′; third shock (slight) at 10h. 41m. 14s.; all three registered on the declination curve.

Wilhelmshaven (Dr. C. Börgen).—The needles of two instruments (declination and Lloyd's balance) oscillated so strongly that the light-point for some time made no impression on the paper. Declination: from 10h. 37m. 55s. to 10h. 43m. 25s. a.m., gap in the curve, oscillations perceptible till 10h. 49m. 55s.; the needle then became steady, but oscillations were again visible from 10h. 52m. 25s. to 10h. 56m. 25s. Bifilar: magnet in oscillation from 10h. 38m. 55s. to 10h. 44m. 55s. Lloyd's balance: from 10h. 38m. 25s. to 10h. 47m. 55s., gap in the curve, then till 10h. 54m. 25s. oscillations traceable.

Utrecht (M. M. Snellen).—The magnetic curves show a disturbance beginning at 10h. 37m. a.m., reaching a maximum at 10h. 41m., and followed by a second maximum at 10h. 52m. 46s.

Parc Saint-Maur (M. Moureaux).—The pulsations are registered on the magnetic curves at 10h. 40m. a.m. They are most marked on the bifilar curve, and much less appreciable on the vertical force curve. The declination curve shows a second movement seven or eight minutes after the first. The gravity-barometer curve indicates a slight depression of the mercury at the moment of the principal shock. The two copper bars, with bifilar suspension, orientated north-south and east-west, were undisturbed by the shock.[1]

Kew (Mr. C. Chree).—There is a very slight movement on both the horizontal force and declination curves, from 10h. 41m. to 10h. 46m., that on the former being the more conspicuous. The vertical force curve shows no disturbance.

In the following table are given the velocities of the earthquake-pulsations obtained from the different records. The epoch used in each case is the beginning of the pulsations, and the initial time that given by M. Coumbary.

Place.	Distance from epicentrum in km.	Time-interval in secs.	Velocity in km. per sec.
Bucharest	416	131	3·18
Nicolaiew	707	156	4·53
Pola	1303	517	2·52
Potsdam	1742	504	3·46
Wilhelmshaven (Declination) ...	2097	595	3·52
,, (Bifilar)	,,	655	3·20
,, (Lloyd's balance)	,,	625	3·36
Utrecht	2185	540	4·05
Parc Saint-Maur	2240	720	3·11
Kew	2518	780	3·23

The average velocity of the pulsations of the principal earthquake obtained from the above ten records is 3·42 ± ·12 km. per sec.[2] A more reliable estimate will probably be obtained by omitting the records from Nicolaiew and Utrecht; the former because the horizontal pendulum is far more sensitive than the magnetographs, and the latter because the time given is that of the beginning of the small pulsations. The remaining records (of the beginning of the large pulsations) give for the average velocity 3·20 ± ·07 km. per sec.

This value agrees very closely with that obtained for the pulsations of the Greek earthquake of April 27, 1894, namely 3·21 ± ·07 km. per second (Report of the B.A. Earth Tremor Committee, 1894), and also with several values determined by Dr. von Rebeur-Paschwitz. It hardly differs, again, from the average velocity between Constantinople and Bucharest, showing that the pulsations and the vibrations which constitute the shock, even if they were independent, travelled at about the same rate.

There is some doubt as to the identity of the second group of pulsations recorded on some of the curves with one another or with one of the earthquakes at Constantinople. Those at Wilhelmshaven and Utrecht seem to follow by too long an interval to be due to the third shock at 10h. 35m. a.m. G.M.T. It is not impossible, however, that the second group at Pola, Potsdam, and Parc Saint-Maur may be connected with this earthquake. If this be the case, the velocity of the pulsations to these places would be 3·28, 4·79, and 2·99 km. per second, respectively, and the average of the three 3·69 km. per second.

CHARLES DAVISON.

King Edward's High School, Birmingham.

[1] It has been inferred, from the steadiness of the copper bars, that the movement of the needles is of magnetic and not of mechanical origin (see *Comptes Rendus*, vol. cxix. 1894, pp. 251-252, and NATURE, vol. l. 1894, p. 394). But is not the centre of gravity of the copper bar equidistant from the two points of support, and that of the declination needle nearer the south support (in order that the needle may rest horizontally)? And, if so, might not the movement be of mechanical origin? (See *Geol. Mag.* vol. ii. 1885, pp. 210-211).

[2] With the initial times as given by the two stopped clocks mentioned by Mr. Wrench, the corresponding values of the velocity would be 2·30 and 2·56 km. per sec.

Photo-electric Phenomena.

A SHORT time ago, a report was given in NATURE (vol. xlix. p. 226) of modern researches respecting the photo-electric discharge of negatively electrified bodies. But no mention was made of our investigations on the same subject, although they were published in a series of articles, from 1889 to 1894, in *Wiedemann's Annalen* and in the *Wiener Berichte*. As the results of these researches seem to be unknown to English physicists, we enumerate them here in brief, in the hope that they will prove of some interest.

Well-cleaned plates of aluminium, magnesium, and pure or amalgamated zinc are, when negatively electrified, discharged in a few seconds by the light of the sun and the cloudless sky. The active rays extend from the blue part of the spectrum to the farthest ultra-violet, so that the active rays are almost completely absorbed by transmission through glass. Hence a well-amalgamated ball of zinc connected with Exner's aluminium-leaf electroscope may be used as a photometric apparatus to settle the amount of ultra-violet radiation emitted by the sun and the sky which reaches the earth's surface. Measurements of this kind were made by us in 1890, during June in Wolfenbüttel, and during July on the top of the Sonnblick. The discharging power of sunlight at a level of 3100 metres (*i.e.* on the Sonnblick) was found to be twice as great as at a level of 80 metres (Wolfenbüttel), corresponding to the greater proportion of blue and ultra-violet rays. These results are in conformity with Langley's well-known researches on the absorption of the blue sunlight by the atmosphere.

The more electro-positive a metal is, the larger the wave-length of light capable of producing a photo-electric discharge. Photo-electric cells of high sensibility were therefore made by using cathodes of metallic sodium, potassium, and rubidium, arranged in a glass bulb, and dipping in an atmosphere of rarefied hydrogen. The leakage of negative electricity from a sodium or potassium surface is produced even by the light of a candle at six or seven metres distance from the cell, and rubidium-cells are sensible to the weak light sent out from a red-hot glass-rod.

The photoelectric discharge by the action of ordinary daylight is also shown in a clear way by some *non-metallic* bodies, *e.g.* by the phosphorescent combinations of calcium with sulphur, and by the dark-coloured kinds of fluorite. Other minerals show traces of the same phenomenon. It is, therefore, probable that the sunlight and the daylight cause the negative electricity of the earth's surface to be partly dissipated into the air. If this theory were correct, it would give a foundation to the explanation of the daily and yearly variation of atmospheric electricity. For three years we have together made measurements respecting the ultra-violet radiation of the sun and the amount of atmospheric potential at the same time, and the results agree with this supposition.

By using the liquid alloy of potassium and sodium, which, in an atmosphere of rarefied hydrogen, shows a reflecting surface, we are able to study the influence of polarised light upon the photo-electric discharge. The maximum intensity of the photo-electric current is observed when the plane of polarisation is perpendicular to that of incidence.

The photo-electric discharge is sensitive to exterior magnetic influences in a similar way to the luminous discharge in a Geissler's tube. In a strong magnetic field it almost entirely ceases.

Electrical vibrations set up by the Hertz vibrator pass through a Geissler tube provided with an alkaline metal electrode far easier in daylight than in darkness. With a sensitive arrangement the weakest traces of light are sufficient to start the luminous discharge.

In one case the disruptive electrical discharge *ceases* when light is applied. If the sparks of an influence machine are

allowed to pass between a brass ball as anode, and the cleaned surface of an amalgamated zinc disc as cathode, they *disappear* in the presence of magnesium light. And if the distance between ball and plate be enlarged, the magnesium light will also hinder the formation of positive electrical brushes.

[*Cf. Wiedemann's Annalen*, Bd. 38, p. 40; 38, p. 497; 39, p. 332; 41, p. 161; 41, p. 166; 42, p. 564; 43, p. 225; 44, p. 722; 46, p. 281; 48, p. 625; 52, p. 433; and *Wiener Berichte*, Bd. 101, p. 703. March 1892.]

J. ELSTER.
Wolfenbüttel, August 12. H. GEITEL.

A Remarkable Meteor.

ON the evening of August 26 (Sunday) I saw what was to me an unprecedented sight: a brilliant and curious "meteor" fell near Gloucester. Starting from a point a little to the west of κ "Draco," at 10h. 19m., falling in the direction shown in Fig. 1, through about an angle of 40°; when it reached point X,

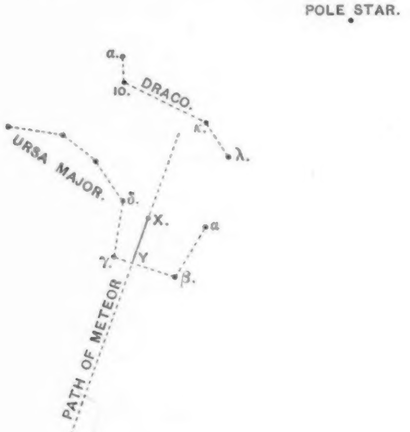

FIG. 1.

it appeared to melt, and its path from X to Y was marked by a most brilliant stream of light, equalling in intensity a magnesium flame.

This luminous streak from X to Y remained stationary and brilliant for nearly two minutes; then the lower extremity gradually curled around, forming the letter J, as shown in Fig. 2; the ends gradually converged until they met, forming a somewhat irregular band, and travelling in the path indicated by the arrow in Fig. 2.

As it traversed the heavens it seemed like a phosphorescent or nebulous cloud, finally assuming the shape shown in Fig. 2;

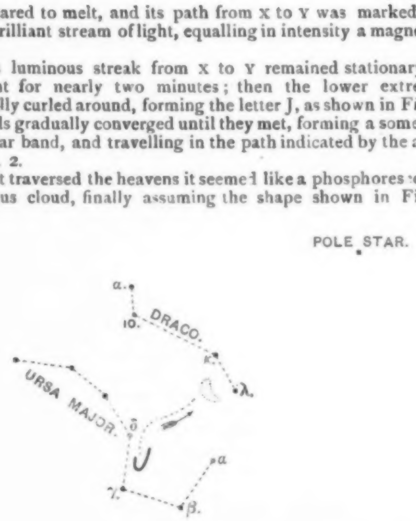

FIG. 2.

between κ and λ "Draco," then gradually becoming fainter and fainter, until at 10h. 41m. (just twenty-two minutes after the "meteor" fell) it became invisible, at a point as much to the eastward of κ "Draco" as the "meteor" had started from the westward of it. I should like to know if any of your readers have seen a similar phenomenon, or if it is of common occurrence.

JOHN W. EARLE.
Gloucester, August 27.

A New Rhynchobdellid.

IT seems hard to believe that a leech, common and abundant and possessing a chitinous dorsal scute, should have hitherto escaped notice. But Jackson, in his edition of the "Forms of Animal Life," does not refer to such a structure, nor does Lang, and I do not find notice of it in more recent literature. In the hope that I am not adding a needless synonym, I give a short description of the animal, of which a detailed account is in preparation.

(*Glossiphonia?*) *scutifera*, n. sp. Sub-cartilaginous, semi-transparent, greenish grey above, paler beneath; obscurely striated above, with a row of dark spots on either side of the middle line. Body widest about 40th annulus, tapering thence abruptly to the disc and gradually to the head, which is narrowest, and not marked off from the succeeding annuli. Annuli 64, ganglia 22. Length in full extension about 1 inch, at rest 3-8ths of an inch. Eyes two in centre of head. Genital apertures behind 21st and 23rd annuli. The 9th annulus is broader than its neighbours, and carries on the hinder part of its richly glandular dorsum a chitinous plate slightly elongated transversely, covering about an eighth of the width of the annulus; in young specimens the margins are overlapped by the integument. Anus dorsal.

This species is meanwhile referred to Glossiphonia, to which it bears a general resemblance. JOHN YOUNG.
Glasgow University, August 28.

The Bleaching of Beeswax.

CAN any of your correspondents inform me how to bleach beeswax chemically, satisfactorily, and at a moderate cost?
August 28. J. S. D.

SUNSHINE AND WATER-MICROBES.

THE bactericidal action of light is perhaps of most general hygienic significance in connection with the fate of micro-organisms in water, and there is ample field open for investigation in this direction, which so far has been but little explored. It is, therefore, with especial interest that we note Prof. Buchner's important contribution to this subject in the *Archiv für Hygiene*. The title of the paper ("Ueber den Einfluss des Lichtes auf Bacterien und über die Selbstreinigung der Flüsse") already indicates that the practical aspect of the question has been considered, and indeed several experiments have been planned and carried out with the object of ascertaining what is the part played by sunshine in the alleged bacterial purification which takes place in river-water during its flow.

In the first series of experiments samples of boiled tap-water were inoculated with three drops of broth-cultures of the typhoid bacillus, *B. coli communis* and *B. pyocyaneus* respectively. The typhoid bacilli, even in diffused daylight, were reduced in numbers from 7400 per c.c. to start with, to 5000 at the end of one day, whilst on the second day none whatever were found. The *B. coli communis* sample had only 220 left on the third day, out of 22,600 at the commencement of the experiment, and was sterile on the fourth day; the *B. pyocyaneus* was, however, hardly affected at all during four days' exposure to diffused light.

The direct rays of the sun, however, were far more destructive. Thus about 50 c.c. of a sample of typhoid-infected water, placed in glass dishes and exposed to sunshine, contained no typhoid organisms at the end of six hours, and similar results were obtained with the *B. pyocyaneus*.

In all these experiments the perfectly admissible objection could be urged that the diminution in the numbers present might, at any rate in part, be attributed to a process of starvation in consequence of the absence of food-

material, inasmuch as a marked decrease was also observed in those samples kept in the dark. To meet this objection, in the next series unsterile water was used, and to a litre and a half as much as 1 c.c. of the broth-culture of the particular organism was added, thus affording ample provision, both in light and darkness, for the support of the bacteria under observation. Instead of a decrease taking place in the samples kept in the dark, the numbers rose; on the other hand, in the samples placed in the sunshine, three hours' exposure in the case of the typhoid, colon, and pyocyaneus bacilli brought about their entire destruction, thus placing beyond doubt the direct bactericidal action which had taken place during insolation.

The amount of water used being small, no indication was given, in these experiments, of the *depth* to which the bactericidal action of the sun's rays could extend. Fol and Saracen ("Sur la pénétration de la lumière du jour dans les eaux du lac de Genève," *Comptes Rendus*, 1884) have shown by the exposure of gelatine-bromide plates that daylight penetrates to a depth of 170 metres in the water of the Lake of Geneva, the degree of light at this depth being about equal to that which we find during a bright but moonless night, whilst at a depth of 120 metres the strength of light is still considerable. These investigators also made the curious observation that in the experiments they conducted, the light penetrated far deeper into the water in September, during cloudy weather, than in the month of August with a perfectly clear sky. Thus not only does the power of light vary at different depths and, doubtless, in different waters, but it is also influenced by the time of year; and what, therefore, may be correct of a given water under certain circumstances, may not necessarily apply to it on another occasion, and hence a good deal of uncertainty attaches to the exact degree of light capable of transmission in any particular mass of water.

Prof. Buchner has endeavoured to ascertain at what depth in the water of the Starnberger Lake, near Munich, light ceases to have any *bactericidal* action. For this purpose he used his well-known process (described in the *Centralblatt für Bakteriologie*, vol. xii. August 1892) of exposing partially protected agar-agar dish cultures. This ingenious method consists in covering over parts of a glass dish containing agar-agar, in which certain varieties of bacteria have been evenly distributed, with variously-shaped strips of black paper or lead, so that the light is screened from these particular portions of the surface. In this manner the bacteria immediately beneath the covered part of the culture-medium are protected from the antiseptic action of light, whilst the rest of the agar-agar and its contents is freely exposed; the result of which is that, in the shaded part of the dish the colonies make their appearance, but in the remainder, having been subjected to the action of light, no bacterial growths, or only very feeble ones, are visible. This is beautifully exhibited in a few days' time by the shape of the black letters or other figures being sharply delineated by the abundant growths which have taken place beneath them from the blank remainder of the dish where nothing is visible, no colonies having developed.

Recently infected agar-agar dishes, partially screened with a leaden cross, were lowered to particular depths in the Starnberger Lake. The day selected was very fine and sunny, and the exposure was continued for 4½ hours, the temperature of the water being 15° R. The site was the starting-place of the steamers, and the water was not quite clear, this being doubtless due to the disturbance caused by the plying to and fro of the vessels.

It would have been more striking, perhaps, if Prof. Buchner had used only one variety of organism throughout, as then all chance of characteristic individual differences disturbing the progressive results would have been obliterated.

The following table shows the results obtained:—

Depth of the dish in the water.	Particular organism employed.	Development of the colonies.	
		In the shaded portion of the dish.	In the exposed part of the dish.
0·1 m.	Cholera	Very strong	None
1·1 m.	*B. pyocyaneus*	"	"
1·6 m.	Typhoid	"	"
2·6 m.	*B. pyocyaneus*	Decidedly stronger than in exposed portion	Fairly strong
3·1 m.	Typhoid	Slightly stronger than in exposed portion	Strong

At a depth of 1·6 m. the bactericidal action of the sun's rays, as shown by this method, is equal to that produced outside the water; but at 2·6 m., however, the action is much less apparent, and in fact is only just perceptible. Thus, as has been suggested elsewhere,[1] the antiseptic potency of the sun's rays ceases a long time before the light becomes affected by the depth of water it has to traverse.

These experiments are of particular interest and importance, because they show very clearly that the agency of light in purifying water cannot be regarded as of much importance. So much stress has recently in Germany been laid upon the self-purification of river-water, that the advisability of permitting the sewage of cities of the magnitude of Cologne to pass untreated into the Rhine, has been publicly discussed on the assumption that in its subsequent flow all objectionable matters will disappear, one of the agencies cited as materially assisting in this magic destruction being sunlight. It is, however, sufficiently apparent that the action of light can only affect a very small fraction of the whole mass of water, for we know that bacteria exist in large numbers at depths very considerably below those which insolation can embrace, whilst there are only a few months in the year, at any rate in our northern climes, when the sun's action is sufficiently strong or prolonged to produce any appreciable effect even in the upper layers of the water.

Prof. Buchner concludes his paper with some investigations carried out by his assistants on the River Isar, 10 km. above Munich. These experiments were made to ascertain if any increase from the number of organisms present during the daytime takes place in the night, as in the absence of light might reasonably be anticipated. Dr. Minck and Dr. Neumayer, therefore, undertook on a September night to abstract samples from the river at ¼ m. below the surface at intervals of from 1–2 hours from 6 o'clock in the evening until 6 o'clock the next morning. The temperature of the water during this time only varied between 9°–10° R., and the samples were examined immediately after collection. The results are recorded in the following table: —

Time of taking sample.	Number of microbes in about 20 drops of water.
6¼ evening	160
8¾ "	5 [2]
11 "	8 [2]
12 "	107
1¾ morning	380
3 "	460
4 "	520
5 "	510
6¼ "	250

It would be interesting to have further confirmation of the results here given, other factors having doubtless assisted besides the absence or presence of light; but the arduous nature of the experiments will doubtless greatly militate against such a series being sufficiently often made to permit of any definite conclusions being arrived

[1] "Bacterial Life and Light," *Longman's Magazine*, September, 1893.
[2] No explanation is offered for these abnormally low figures.

at. In this connection, it may also be noted that in the year 1886 the Thames water at Hampton contained twenty times as many microbes in the winter as were found in the summer months. Here again the consideration of other agencies also tending to influence the bacterial condition of the river water cannot be excluded, but sunshine undoubtedly assisted in the banishment of the microbes. G. C. FRANKLAND.

NOTES.

THE Municipal Council of Paris has opened competitions for the best means of suppressing or diminishing the smoke of cities, and of purifying water. To the author of the best memoir on the former subject, the sum of ten thousand francs will be given, and two other prizes will be awarded of five thousand and two thousand francs respectively. The memoirs must be sent in before November 1. Prizes varying from one thousand to three thousand francs will be awarded for the processes of water purification which give the best results. Papers relating to this must reach the Council before September 15.

THE death is announced of Dr. Karl Neumann, Professor of Chemistry in Zürich Polytechnic School, at the age of forty-three.

WE learn from the *Athenæum* that Father Epping, S.J., died on August 22. He was one of the highest authorities on Assyrian astronomy and chronology, on which subject he published, in conjunction with Father Strassmaier, a valuable treatise some years ago.

THE tenth International Congress of Orientalists was opened at Geneva on Tuesday. Fourteen Governments, and ninety-seven Universities or learned societies, have sent delegates to the meeting.

THE International Congress of Hygiene and Demography is now being held at Budapest. We hope to give a report of the proceedings after the meeting has ended.

THE Association Géodésique Internationale met at Innsbruck yesterday. M. Faye, M. Bouquet de la Grye, and M. Tisserand were delegated by the Paris Academy of Sciences to attend the meeting.

THE International Meteorological Committee held its meeting, as arranged, at Upsala, August 20-24. M. Wild, the president, was unfortunately prevented from attending, owing to indisposition. M. Mascart was elected president for the meeting, and Mr. Scott, as usual, secretary; the other members present were Prof. v. Bezold (Berlin), Dr. Billwiller (Zürich), Mr. W. G. Davis (Cordoba), Dr. Hann (Vienna), M. Hepites (Bucharest), Dr. Hildebrandsson (Upsala), Prof. Mohn (Christiania), Dr. Paulsen (Copenhagen), M. Snellen (Utrecht), and Prof. Tacchini (Rome); the absentees were, in addition to the president, Admiral de Brito Capello (Lisbon), owing to health, and Messrs. Eliot (Simla), Ellery (Melbourne), and Harrington (Washington), owing to distance. The principal points dealt with at the meeting were as follows:—(1) The establishment of an International Meteorological Bureau was recognised as impracticable. (2) It was resolved to publish in the report of the meeting a *résumé* of the measures adopted in all countries to communicate to agriculturists meteorological results likely to be useful to them. (3) The acceleration of meteorological telegrams. It was decided to address the International Telegraphic Bureau at Berne on this subject. (4) The scintillation of stars as an indication of weather. A paper by M. C. Dufour will be reproduced in the report. (5) The study of clouds. This was the *pièce de résistance* at the meeting. The Cloud Committee, appointed at Munich in 1891, held a meeting at the same time as the International Meteorological Committee, and presented a report dealing with definitions for the ten classes (Hildebrandsson and Abercromby) adopted at Munich, and with instructions for cloud observations. They also proposed to prepare and issue an authoritative cloud atlas. This report was carefully discussed and, after modification, adopted. The members of the Cloud Committee who were present at the meeting, were Prof. Hildebrandsson, Dr. Hann, Prof. Mohn, Mr. A. L. Rotch (Blue Hill Observatory), M. Teisserenc de Bort. In addition, the following gentlemen were admitted, but without voting power: Prof. v. Bezold, Dr. Billwiller, and Mr. Davis (of the International Meteorological Committee), and Prof. Broounof (Kieff), Dr. Fineman and Dr. Hagström (Upsala), Prof. Riggenbach (Basle), Prof. Sprung (Potsdam), and M. Philip Weilbach (Copenhagen). (6) The subject of the treatment of the wet bulb below the freezing point was discussed, and the use of Ekholm's formula was recommended *ad interim*. (7) It was decided to arrange for a conference of the same character as that at Munich in 1891, which was not an official congress, to be held in Paris in September 1896. M. Mascart and Mr. Scott were requested to make the necessary preparations, such as the arrangement of the programme, &c.

THE great pine forest region in the States of Minnesota and Wisconsin has been devastated by fire. There had been no rain in the district for nine weeks, and the trees had therefore become very dry and inflammable. Forest fires occurred in the early part of last week, but their advance was checked. On Friday, however, several fires broke out almost simultaneously, and the flames spread with alarming rapidity. Many towns and villages were entirely destroyed, and it is estimated that nearly one thousand lives were lost.

A RECENT number of the official organ of the National Department of Hygiene in Buenos Ayres, a copy of which has been sent to us, calls attention to a hygienic exhibition which is to be held in that city at the close of this month. The authorities hope that it may render important service in helping to establish a permanent museum of practical hygiene, besides stimulating public interest in sanitary questions generally. The journal also contains many useful notices of original work published in various foreign papers.

THE current numbers of the *British Medical Journal* and the *Lancet* should be obtained by everyone desirous of entering the medical profession. They are almost entirely devoted to descriptions of the universities, corporations, and colleges which grant the degrees and diplomas required by a medical practitioner. Prospective students will find our contemporaries complete guides to the medical calling. They will also find that to succeed in this noble profession it is necessary that a man "should be imbued with a love of humanity and a love of science, and should be indifferent to the worship of the god of the modern world—the golden calf. No man whose aim is to make a fortune should dream of entering the medical profession. Let him learn the grocery business or the drapery business; he will not only fail in medicine, but will help to degrade it." These remarks are applicable to students of most branches of science.

SOME years ago, an observatory was established on the Saint-Jacques tower in Paris, under the direction of M. J. Jaubert. The institution is of a private nature, but it is furnished with

good instruments, and has from time to time issued useful bulletins. An interesting report upon the atmosphere of Paris is published in the supplement of *La Nature* of August 25, based on the observations made between July 1, 1891, and December 31, 1893, which shows very clearly the influence exerted on meteorological elements by a large mass of houses. M. Jaubert had compared the observations at his own observatory with those at the official observatory at Parc Saint-Maur, in the suburbs of Paris. The tables show that the variations of pressure between the two places are very small, but that temperature, especially towards the evening, is from 3° to 4° F. higher in the city, while the maxima and minima occur some hour or two later than in the country. The amount of cloud has this peculiarity, that during the evening the sky is clearer over Paris than in the suburbs. All other elements, rainfall, wind, &c., have been compared, and some interesting details as to visibility are also given. We published some time since (vol. xlix. p. 460) a similar comparison with reference to the temperature of Berlin. Such statistics are of great practical value, especially to persons living near large towns.

AMONG some of the old German legends concerning the weather, the recent meteorological conditions experienced in Gottingen and its neighbourhood have turned nearly everyone's mind to that very old one called the "seven sleepers," or "Die Siebenschläfer." That such a belief should still be held to these old legends is not to be wondered at, even in these days of forecasts, &c., for were they not to a great extent founded on real, although roughly observed, facts which had been noticed over the space of many years, and at last become legendised? The legend of the Siebenschläfer runs as follows:—Seven Christian youths, Maximianus, Malchus, Serapion, Dionysius, Johannes, Martinianus, and Konstantinus, in the reign of King Decius, 251, fled to the mountains because they would not follow the Jewish religion. In a mountain called Kalion, near Ephesus, they found a large cave, into which they entered, slept, and ultimately became shut in. It was not till the year 446, under the reign of Theodosius, that this cave was accidentally opened, and the seven sleepers woke up from their long sleep of nearly 200 years, Bishop Martin and the king being both witnesses to this wonder. The Christians died eventually surrounded with glory and honour. The saying which has come down to us to-day, and which, curiously enough, connects these holy men with the weather, is that, if it should rain on June 27, we must expect rain for the following seven weeks; this is for the Roman Church. In the Greek Church this day is held on August 4, while the "Acta Sanctorum" name July 27 for its remembrance. It may be of interest, however, to see whether the application of this old legend to the weather recently experienced holds good. Taking the Roman Church Calendar as our reckoning, and commencing on June 27, the seven weeks would then terminate on August 14. Unfortunately rain did not happen to fall on the 27th at the place in question, but records show that both the day before and after it was experienced. On the 29th and 30th also no rain fell, but with the exception of July 6, 29, and 30, rain has fallen daily until August 14. Thus from June 27 to August 14, both days inclusive, a period of 49 days, only six days were recorded without rain, but rain did *not* actually fall on the 27th. One infers from the legend that at the end of this period fine weather should be the order of the day, that is to say, if according to the "Sieben Brüdern" it did not rain on July 10. Unfortunately or not, as the case may be, 1·5mm. on 200 square cm. of rain were recorded, which means, according to the latter legend, that it must rain for seven weeks after this date. At the time of writing, August 24 (7 p.m. Central European time), it has rained daily since the 14th, so that the "Sieben Brüdern" seems as if it will be verified. The meteorological records referred to above we owe to Herr A. Spörhase, meteorological observer at the Physical Institute, Göttingen.

AT a recent meeting of the Société Française de Physique, M. Bouty read a paper on the capacity of the capillary electrometer. The author supposes that the two quantities of mercury are brought to a difference of potential e, and that the surface of the mercury in the capillary is brought back to the zero by increasing the pressure, and that a quantity of electricity dQ is then supplied without changing the pressure. The capacity of the apparatus, under these conditions, consists, according to Lippmann's theory, of two parts, one term proportional to the square of $\frac{dA}{de}$ where A is the surface tension and represents the quantity of electricity absorbed or produced by the change in the form of the small surface of mercury, and has the preponderating influence when e is nearly zero. The other term which is proportional to $-\frac{d^2A}{de^2}$ is only of importance when A is near its maximum. In order to measure the capacity C which is equal to $\frac{dQ}{de}$ the author measures separately the corresponding values of δQ and δe within such limits that proportionality exists between these quantities. He produces a constant quantity of electricity (δQ) by means of a piezo-electric piece of quartz, and discharges it into the electrometer, whose capacity may be considered as infinite compared to that of the quartz. He then determines by means of a derivation on the circuit of the charging battery the increase δe of the electromotive force necessary to reproduce the same shift in the mercury as was produced by δQ. In every case the observed values agreed with those deduced by means of Lippmann's theory.

M. W. SPRING, who about fifteen years ago proved the possibility of welding metallic bodies by simple pressure at temperatures far below their fusing point, publishes an interesting extension of his researches in the *Bulletin de l'Académie Royale de Belgique*. He was led to the conclusion that at a certain temperature, where a metal is to all appearances a perfect solid, a certain proportion of the molecules attain a rate of vibration corresponding to the liquid state, and that these molecules, by softening the body, make it capable of welding and of producing alloys with other metals. The metals were put in the shape of cylinders bounded by plane surfaces, upon the purity of which great care was bestowed. They were then mounted in a stirrup, and pressed together by means of a hand-screw. In this state they were placed in a heating oven, and kept at a constant temperature between 200° and 400° for from three to twelve hours. The most perfect joints were produced with gold, lead, and tin, and the worst with bismuth and antimony. Two cylinders thus welded together could be put in a lathe, one of them only being held in the chuck, while the other was being worked upon by a cutting tool, without coming apart. They could be separated with the aid of pincers, but then a rough breakage was produced which did not coincide with the original plane of separation. It appears that the more crystalline the bodies are the less do they exhibit this phenomenon of incipient liquefaction, which begins to show in the case of platinum, for instance, at 1600° below its fusing-point. That such a liquefaction or softening actually takes place was proved by cutting a delicate spiral 0·2 mm. deep on the end surface of a piece of copper weighing 130 grammes, and placing it upon a sheet of mica. After keeping it at 400° for eight hours, the spiral had entirely disappeared, and the surface looked as if just fused before the blowpipe. Where two

metals were employed, alloys were formed, which, in the case of lead and tin, were fusible and flowed out at 180°. By placing a perforated disc of mica between the two, the outflow could be prevented, but the alloy formed at the centre and the metals were hollowed out in the proportion of their degrees of liquefaction. In a lead-antimony couple, the hole in the lead was 8 mm. or 9 mm., and that in the antimony 2 mm. The most striking and novel experiments, however, were those showing the evaporation of metals, or rather their sublimation, at temperatures between 300° and 400°. This was also shown by inserting a disc of mica, say, between a zinc and copper couple at 360°. When air was carefully kept away from the surfaces, the copper was tinted a golden yellow over the area of the hole in the mica, the exact colour of tombac, and a brown layer was produced on the zinc, which chemical analysis proved to contain copper. Similar results were obtained with cadmium, the thickness of the mica being 0·8 mm.

WE have received a copy of the *Jahres-Bericht des Vereins für Naturkunde of Mannheim*, in which a brief account is given of the proceedings of the Society during the years 1889–93 inclusive. It appears that in spite of the population of Mannheim having doubled itself during the past eighteen years, the Society has not increased in numbers. That it should have maintained a bare existence must be considered very creditable to the energy of its members, for we read that Mannheim, as perhaps no other commercial or industrial centre, possesses so few attractions in the shape of social or scientific intercourse that the inhabitants as soon as they can retire from work leave the city to settle elsewhere. A similar nemesis unfortunately overtakes some of our local naturalist societies, and Mannheim cannot claim the unique position ascribed to it by the president of its Naturkunde Verein! The greater part of the pamphlet is occupied by an elaborate paper, by Dr. Migula, entitled "Methode und Aufgabe der biologischen Wasseruntersuchung." The endeavour is made to build up a bacteriological standard of purity for water, not according to the number of microbes, but from an estimation of the particular varieties present in a given sample of water. We are not surprised to find Dr. Migula willing to resign this herculean task to others to work out.

MR. W. A. SANFORD read before the Somerset Archæological and Natural History Society, at its late meeting at Langport, a paper in which he announced his discovery, in the Rhætic beds at Wedmore, of a large Dinosaur. The animal appears to have been carnivorous, and, though very much larger, to have resembled *Megalosaurus Bucklandi* of the Stonesfield slate. The remains at present available for study are about twelve vertebræ, a large portion of the pelvis, some portions of the mandible, some teeth, a nearly complete femur, parts of a tibia and of both fibulæ, some phalanges, including a perfect claw-bone, and fragments of ribs and of other small bones, and other larger fragments that may be placed. The bones are accompanied by fossils of Triassic date, which render their geological position a matter of nearly absolute certainty. The results of a complete and close examination of the bones will be of considerable interest.

IN addition to a preliminary note on some new species of fish, belonging to the genera *Characodon* and *Atherinichthys*, from the Mexican Seas, by Dr. F. Steindachner, the June number of the *Proceedings* of the Imperial Academy of Science of Vienna (1894, No. xv. pp. 147–154) contains a communication from Prof. Weisner upon the results of a physiological investigation upon some interesting points in the germination of the mistletoe and its European and tropical allies (*Viscum* and *Loranthus*). The author finds a considerable difference between the seeds of the European and tropical forms as regards their reaction to light and moisture, and as to the existence or duration of a "resting period." These differences and peculiarities, however, he is in all cases able to interpret as specific adaptations to differences in the natural conditions of life. The viscid envelope of the seeds in all the parasitic species is undoubtedly an adaptation for ensuring the attachment of the seed to the bark of its host; but Prof. Weisner regards its great development in the common mistletoe (*Viscum album*) as also serving to retard the process of germination. There is practically no resting period in the case of the tropical species, and in them the viscid pericarp is developed in much smaller quantity; and the seeds of our own *Viscum album* germinate most readily when freed from their mucilaginous investment. It is to be hoped that Prof. Weisner will publish before long a fuller account of his interesting researches, and that he will also incorporate some statements as to the effects of temperature upon the germination of the same seeds.

IN an elaborate paper "Étude expérimentale sur le charbon symptomatique" (*Annales de l'Institut Pasteur*), Dr. Duenschmann describes some extremely interesting and suggestive experiments which he has made on the effect of associating a virulent with a non-virulent micro-organism in animal inoculations. For this purpose the well-known bacillus *prodigiosus* was introduced into guinea-pigs along with the bacterium *Chauvœi*, the exciting cause of symptomatic anthrax. Under ordinary circumstances the latter microbe will kill guinea-pigs in eighteen hours, but, strange to say, its lethal action is delayed for four days, when it is associated with the *B. prodigiosus*. M. Roger already found that the rabbit, an animal not easily susceptible to symptomatic anthrax, may be readily infected if cultures of the *B. prodigiosus* are introduced along with the *B. Chauvœi*, and similar observations in the case of other disease microbes, associated with this harmless bacillus, have been made by others. Dr. Duenschmann, however, has carried his investigations still further, and has found that the *B. prodigiosus*, usually regarded as an innocent saprophyte, will, if used in sufficient quantities, kill guinea-pigs when introduced into the peritoneum. The chief interest of Dr. Duenschmann's experiments lies in the contribution which they afford to the important subject of the *associated* action of micro-organisms. The bacteriological study of disease has so far been mainly carried on with single varieties of microbes; but it must not be forgotten that in nature infection with a pure culture, or one variety of organism, is the exception and not the rule, and that in working with mixtures of micro-organisms we may obtain much important assistance in understanding the intricate and puzzling course run by so many diseases.

THE annual report of the Russian Geographical Society for the year 1893 is so full, that only in a publication specially devoted to geography would it be desirable even to enumerate the headings of its varied contents. All we can do is to mention the parts which possess general interest. Such are the remarks of M. Obrucheff on the Eastern Gobi between Urga and Pekin, which has the characters of a steppe, but not of a desert, as it receives a regular amount of rain in the summer, and is covered then with grass, while true deserts are found in small limited portions only of its vast area. M. Obrucheff's find of a skull of a rhinoceros, probably *Tichorhinus*, in the lake deposits of the Ordos, in latitude 38° N., is also worth mentioning. E. G. Fritsche's measurements of the magnetic elements in the neighbourhood of Moscow, where an anomalous distribution had been observed, show that the anomaly is due to the presence, at a depth which is estimated at ten kilometres, of large iron masses. M. Komaroff's measurements of the movement of the Zerafshan glacier and the exploration of its former much greater extension, as

also his levellings in the Transcaspian territory in the region which is supposed to have been the *Area Palus* of the ancients, promise to yield very interesting results. The yearly reports of both the East and the West Siberian Branches of the Geographical Society are also full of geographical information. In East Siberia, M. Prein has explored the vegetation of the Olkhon Island in Lake Baikal, which offers great interest for its curious mixture of species characteristic of the steppes with purely forest species, and which also contains a number of varieties, either unknown or intermediary between different formerly known varieties. In West Siberia, we notice the steady work of the Meteorological Committee which opened last year, in connection with the Central Meteorological Observatory, eight stations in different parts of the territory; M. Siyazoff's work on the flora of the Ishim Steppes, and its comparison with the flora of Tyumen, at the eastern slope of the Urals; M. Katanaeff's larger work on the Kirghiz Steppes; and Slovtsoff's, on the Pelym region and on the Siberian cedar—all published in the memoirs of the West Siberian branch—are also of interest.

A REPORT, showing the distribution and production of some of the most important minerals worked in India, has been issued by the Department of Revenue and Agriculture of the Indian Government.

THE principles of the manufacture of steel are ably described in "Fabrication de la Fonte," by M. E. de Billy, the volume being the latest addition to the Aide-Mémoire series published jointly by Gauthier-Villars and Masson.

THE fifth part of Kerner and Oliver's "Natural History of Plants" (Blackie) has been published. Its contents refer to metabolism and the transport of materials, and to the growth and construction of plants.

WE have received a paper "On the Analytical Treatment of Alternating Currents," read by Prof. A. Macfarlane before the International Electrical Congress held at Chicago a year ago, and reprinted from the Congress' *Proceedings*.

ALL regulations referring to the registration and inspection of classes held in connection with the City and Guilds of London Institute are given in the "Programme of Technological Examinations" just published for the Institute by Messrs. Whittaker and Co.

UNDER the title "Peregrinazioni Psicologiche," U. Hoepli, of Milan, has published a collection of psychological papers by Dr. Tito Vignoli, Professor of Anthropology in the R. Accademia Scienze e Lettere di Milano, and Director of the Museo Civico di Storia Naturale.

THE September number of *The Country Month by Month*, by Mrs. Owen and Prof. Boulger, appears to us to be better than some that have preceded it. The poet-naturalist will find the authors' descriptions of autumnal plant and bird life greatly to his liking. Some parts of the book are really very fine. Messrs. Bliss, Sands, and Foster are the publishers.

THE Manchester Microscopical Society, with a membership of 245, ranks high among provincial scientific societies. Several interesting papers are printed in the *Transactions* of the Society for 1893. Among these we note the address of the president, Prof. F. E. Weiss, on recent researches and speculations on the structure of protoplasm; a paper on modern views of the plant cell, by Mr. Thomas Hick; and one on the organic forms of silica, by Mr. W. Blackburn. A useful summary of information on the plans of growth and the forms of Foraminifera is contributed by Mr. E. Halkyard; and a survey of typical examples of some common microscopic fungi is given by Mr. A. T. Gillanders. These papers show that interest in the Society is still maintained.

THE Meteorological Sub-Committee of the Croydon Microscopical and Natural History Club is doing good work by the collection of rainfall statistics; its report for 1893 contains daily and monthly values for sixty-three stations in the counties of Kent and Surrey. The Hon. Sec., Mr. F. C. Bayard, points out that the smallness of the total rainfall during the year is very remarkable. The average yearly fall for Greenwich for seventy-five years (1816–90) is 25·11 inches; but in the year 1893 there was a deficiency of 5·02 inches, which quantity nearly represents the deficiency of the district dealt with by the Club. Most of this deficiency, viz. 4·77 inches, occurred during the first six months of the year.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. Darent McDonald; a Pinche Monkey (*Midas œdipus*) from New Granada, presented by Lieut. W. N. Gordon, R.A.; a Puma (*Felis concolor*) from Argentina, presented by Mr. Ponsonby Ogle; a Stone Curlew (*Œdicnemus scolopax*), British, presented by Colonel H. W. Fielden; two Poe Honeyeaters (*Prosthemadera novæ-zealandiæ*), from New Zealand, presented by Mr. Reginald Moorhouse; an Elephantine Tortoise (*Testudo elephantina*) from the Seychelles, presented by Mr. Arthur Gladstone; two Hawks-billed Turtle (*Chelone imbricata*) from the East Indies, presented by Captain E. Fleetham; a black-headed Lemur (*Lemur brunneus*) from Madagascar, five Meyer's Parrots (*Pœocephalus meyeri*) from East Africa; two Brown-throated Conures (*Conurus æruginosus*) from South America, deposited; two Javan Wild Swine (*Sus vittatus*) from Java, presented by Mr. E. J. Kerkhoven.

OUR ASTRONOMICAL COLUMN.

RECENT OBSERVATIONS OF MARS.—Mr. John Ritchie, jun., has kindly sent us a cutting from the Boston *Commonwealth* containing some observations of Mars, made at the Lowell Observatory, Arizona, since those recorded in our issue of August 16. The staff of the observatory includes Mr. Percival Lowell, Prof. W. H. Pickering, and Mr. E. A. Douglass. Mr. Lowell himself communicated the following observations to the *Commonwealth*: July 5. Both Pickering and Douglass observed that the terminator was flattened in a certain place. Light from the Sabacus Sinus was found to be polarised. July 19. Douglass observed a protuberance on the terminator, and a notch. The height of the former was estimated at 0"·1, which suggests an elevation of about five-eighths of a mile. July 20. The notch seen by Douglass was confirmed by Pickering. July 21. Douglass saw two notches which were afterwards confirmed by Pickering. July 23. Other notches on the terminator observed by Douglass. July 26. A large protuberance observed by Pickering. The light from the larger "lakes" found to be unpolarised, even when near the limb of the planet. (Mr. Ritchie points out that the projection seen by Pickering was in all probability the one seen by Javelle at Nice, on July 28). The first observation of a canal, Eumenides, was made on June 6 by Pickering. The same channel was seen by the other observers on June 7, and appeared persistently on June 9. During the whole of June and July the snow-cap diminished in size. On July 10, a minute patch of white, in the position of the former star-like points, was seen as a difficult object, entirely detached from the snow-cap. On July 18, Pickering reported that the cap had materially diminished, and that the canals were coming out more clearly. He had some views of clouds and glimpses of some of his "lakes." Early in August he reported that he had seen seventeen of these lakes, two of them new. By the end of June the canal Ganges was seen twice, and both times single. July 29, a light grey tint was seen on an extended region. Some canals were well developed, no duplication visible. July 30, early in the evening, with the seeing 4 and 3 on a scale of 10, Pickering thought he saw Ganges double. Later in the evening, when the seeing had improved to 8 and 9, it was evident that such was not the case. The

apparent double was a canal from Fons Juvente and a north branch of Tithonus. The latter observations have an interest, since the canal Ganges has been reported as having been seen double at the Lick Observatory.

A circular just distributed by the Centralstelle für Astronomische Telegramme, Kiel, states that a telegram, of which the following is a translation, was received from Teramo on August 31:—"Greenish-white spot on the northern cap of Mars. Length thirty to forty degrees. *Nix borea* apparently covers *Mare acidalium*. Cerulli."

THE MASS OF JUPITER.—It was more than twenty years ago, Prof. Simon Newcomb reminds us in the *Astronomische Nachrichten* No. 3249, that he called attention to the great value of observations on the minor planet Polyhymnia for determining the mass of Jupiter. Prof. G. C. Comstock's computations of the special perturbations of the elements of the former planet from the date of discovery in 1854, together with the observations made during the opposition of 1888, have enabled Prof. Newcomb to make this determination. The result obtained shows that the mass of Jupiter is $\frac{1}{1047 \cdot 34}$ part the mass of the sun. Other determinations of Jupiter's mass are shown in the following table, and also the weights assigned to them by Prof. Newcomb, who proposes to regard the weighted mean as definitive, and to use that mass in his work on the planetary theories.

	Jupiter's Mass.	Weight of Determination.
All observations on the satellites ...	1047·82	... 1
Action on Faye's Comet (Möller) ...	1047·79	... 1
Action on Themis (Krueger) ...	1047·54	... 5
Action on Saturn (Hill)	1047·38	... 7
Action on Polyhymnia	1047·34	... 20
Action on Winnecke's Comet (v. Haerdtl)	1047·17	... 10
Weighted mean	1047·35	± 0·065

It is pointed out that in the interests of the astronomy of the future, it is very desirable to apply Gill's heliometer method to the continuous observation of a selected number of minor planets.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE forty-third annual meeting of the American Association for the Advancement of Science was held at Brooklyn, N.Y., from August, 16–22.

The marvel is that no meeting had previously been held in that great city. Overshadowed as it is by the greater metropolis of New York, its next neighbour, many strangers fail to realise that Brooklyn is one of the great cities of the world. By a recent act of the legislature its area has been doubled, and its population now exceeds one million, making it the fourth city in America; until the last census it was the third, but Chicago has now outstripped it.

Not merely as a portion of the metropolis of America, but also in those features which are distinctively peculiar to itself, Brooklyn offers unrivalled attractions to men of science. The massive bridge which spans the East River, connecting it with New York, is a world-renowned triumph of engineering. The United States Navy Yard attracts the attention of those who study applied science, and eleven thousand manufacturing establishments provide valuable object-lessons.

The city is also notable for educational institutions of the best character, including the Pratt Institution, the Packer, the Polytechnic, the Long Island Medical College, the Hoogland Biological Laboratory, a large and well-equipped High School for each sex, and several Roman Catholic Seminaries.

A marked feature of recent meetings of the Association has been the increasing number of affiliated societies which hold meetings in connection with the general Association. Two new accessions bring the number of these already up to nine, and next year the American Botanical Society will still further swell the list, which now includes the American Mathematical Society, the Society for Promoting Engineering Education, the Society for the Promotion of Agricultural Science, the American Microscopical Society, the Geological Society of America, the Association of Economic Entomologists, the American Chemical Society, the Association of State Weather Services, and the American Forestry Association.

The citizens of Brooklyn entered into the arrangements with an evident determination to do everything to insure the success of the meeting. The reception at the Academy of Music and the Art Building, on the opening evening, was perfect in all its details. The excursions were of unusual number and variety, and included features of exceptional scientific interest, such as dredging expeditions by the steamer *Fish Hawk*, furnished by the United States Government. Special mention is also due to the elegant excursion to West End, and entertainment furnished by Mrs. Herrman, a patron of the Association, and of the sterling silver badges of her own design given as souvenirs.

The weather continued cool and comfortable throughout, so that all the external conditions were as favourable as possible. Teleologists even found evidence of providence and prevision in the unusual circumstance that nine century plants bloomed together to welcome the coming Association.

The attendance of members was well above the average of recent years, and if to the registry of the general Association be added the names of specialists attending the affiliated societies, it will raise the total to an aggregate comparing favourably with the largest meetings, notwithstanding that the depression of business and the fear of detention by railroad strikes exerted a deterrent influence.

Three evenings were occupied with popular scientific lectures. Paul du Chaillu spoke on the Vikings, their civilisation and expeditions; Edward D. Cope, on the relation of human structure and physiognomy to those of the other mammalia; and B. E. Fernow, on the battle of the forest.

The annual address of the retiring president, Prof. William Harkness, was on the magnitude of the solar system. An exhaustive account was given of the various methods of measuring the sun's distance. Many of Prof. Harkness' hearers were surprised to learn that but little accuracy has been attained for many years. He states as his conclusion after comparing all the corrected results of these various methods, that the sun's distance is 92,797,000 miles with a probable error of 59,700, and the diameter of the solar system, measured by that of its outermost member, the planet Neptune, 5,578,400,000 miles.

The address of Vice-President George C. Comstock, on binary stars, was of interest, as will be seen from the following extracts. After a general review of the subject, he said that the orbits of forty-two binary stars based on motion of over 80° have been computed. The shortest are δ Equulei and κ Pegasi, each less than twelve years.

ζ Cancri presents a curious study. Two stars less than a second apart revolve in an ellipse; a third star 6″ distant revolves in loops, suggesting an invisible companion. Four binaries have been discovered by the spectroscope: β Aurigæ, revolving in a period of four days; α Virginis, four days; ζ Ursæ Majoris, 105 days; and Algol, three days.

The masses of the visual and of spectroscopic binaries are derived by totally different methods, but both classes of bodies indicate that the sun is an undersized star, a result that is confirmed by other and independent lines of investigation. The small range of values presented by the masses of the stars is remarkable, and points to an unexplained uniformity of size in the heavenly bodies, the average component of a double star having a mass somewhat greater than the mass of the earth.

If binary stars are classified with respect to their type of spectrum, it will be found that on the average the distance of a star possessing a Sirian spectrum is about three times as great as that of a star possessing a solar spectrum, and it will further be found that although stars of the Sirian type are, on the whole, more numerous than solar stars, binaries of solar type outnumber their Sirian fellows three to one.

Four-fifths of the binaries, with periods of less than two hundred years, have orbits smaller than Neptune, while the fastest have orbits between Jupiter and Saturn.

A combination of measured amounts of light with elements of orbit is mass-brightness, or "candle-power per ton" (Young). γ Leonis has more than 1000 times the mass-brightness of 61 Cygni—probably. Confining ourselves to those with well-determined orbits, we find at extremes of the list ϕ Ursæ Majoris, with a mass-brightness fifty-times that of 70 Ophiuchi. The mass-brightness of the sun is probably not much greater than that of 70 Ophiuchi.

It has long been known that if the components of a double

star are of approximately equal brilliancy, they are of the same colour, and if of unequal brilliancy the colour of the fainter companion lies nearer to the violet end of the spectrum than does the colour of the brighter one. The spectra of the stars furnish a partial explanation of their difference in colour by showing, in at least some cases, that the stars possess spectra of different types, the fainter companion having a Sirian, and the brighter one a solar spectrum.

Few researches upon double stars exceed in theoretical interest the mathematical investigations of Mr. See with regard to the mode of development of these bodies. As early as 1878, Doberck had shown, from a statistical comparison of double star obits, that, in general, the longer the period of revolution of the compounds the larger and more eccentric are their orbits. That the orbits would be larger might be expected as a consequence of the law of gravitation, but it required a special investigation based upon the theory of tidal friction, as developed by Prof. G. H. Darwin, to show that the increasing eccentricities are also a necessary consequence of the same law. The conclusions of Mr. See may be briefly summarised as follows:—If we suppose the components of a double star to be composed of a plastic material, they will produce in each other bodily tides whose effect will be to push the stars asunder, and at the same time to increase the eccentricity of their orbits. This increase of eccentricity will not continue indefinitely, but in the later stages of developments will give way to a diminution of the eccentricities, which will ultimately produce circular orbits. But since the energy of the star is being constantly wasted by radiation, it will, in the later stages of its career, be reduced to invisibility, and during the period of its existence as a luminous body its history will present a continuous increase in the size and eccentricity of its orbit. It is of interest to note in this connection that the two orbits of spectroscopic binaries which have been computed, present eccentricities very much less than that of the average double star orbit, while the dimensions of their orbits are so small as to suggest an early stage in the development of the systems.

Prof. Wm. A. Rogers year by year brings to the Association either new and more refined apparatus, or the result of delicate experiments with the perfected apparatus already at his command. This year he presided over the Section of Physics, and read an elaborate address on obscure heat as an agent in producing the expansion of metals under air contact.

Vice-President Thomas H. Norton addressed the Chemical Section, on the battle with fire; Mansfield Merriman, the Engineering Section, on paradoxes in the resistance of materials; Samuel Calvin, the Geol gical Section, on some points in geological history illustrated in North-eastern Iona, exhibiting and using American chalk obtained from the Niobrora beds; Lucien M. Underwood, the Botanical Section, on the evolution of the Hepaticæ, a subject to which he has devoted especial attention, and on which he is probably the foremost authority; Franz Boas, the Anthropological Section, on human faculty as determined by race; and Henry Farquhar, the Economic Section, on a stable monetary standard.

One hundred and seventy-eight papers were read before the Sections, the largest number being before the Section of Anthropology.

It was decided to visit San Francisco next year if suitable rail rates can be secured, and the date of meeting recommended is June or early in July. Definite action, however, was deferred, owing to the expense of crossing the continent, so that time may be taken to apply for special rates of fare.

The following officers for the ensuing year were recommended by the nominating committee, approved by the council, and elected by the Association:—

President, E. W. Morley, Cleveland. Vice-presidents: Mathematics and Astronomy—E. S. Holden, Lick Observatory. Physics—W. Le C. Stevens, Troy, N.Y. Chemistry—William McMurtrie, Brooklyn, N Y. Mechanical Science and Engineering—William Kent, Passaic, N.J. Geology and Geography—Jed. Hotchkiss, Staunton, Va. Zoology—D. S. Jordan, Palo Alto, Cal. Botany—J. C. Arthur, Lafayette, Ind. Anthropology—F. H. Cushing, Washington, D.C. Economic Science and Statistics—B. E. Fernow, Washington, D.C.; permanent secretary, F. W. Putnam, Cambridge, Mass.; general secretary, James Lewis Howe, Louisville, Ky.; secretary of the council, Charles R. Barnes, Morrison, Wis. Secretaries of the Sections: Mathematics and Astronomy—E. H. Moore, Chicago, Ill.; Physics—E. Merritt, Ithaca, N.Y.; Chemistry—William P. Mason, Troy, N.Y.; Mechanical Science and Engineering—H. S. Jacoby, Ithaca, N.Y. Geology and Geography—J. Perrin Smith, Palo Alto, Cal. Zoology—S. A. Forbes, Champaign, Ill. Botany—B. T. Galloway, Washington, D.C. Anthropology—Mrs. Anita Newcombe McGee, Washington, D.C. Economic Science and Statistics—E. A. Ross, Palo Alto, Cal. Treasurer, R. S. Woodward, New York.

WM. H. HALE.

THE IRON AND STEEL INSTITUTE.

THE summer meeting of the Iron and Steel Institute has been held this year, for the second time in the history of the Institute, in Belgium, the former meeting in that country having taken place at Liège just twenty-one years ago.

This year's meeting commenced on Monday, August 20, and continued until the following Friday. The President of the Institute, Mr. E. Windsor Richards, presided throughout. The proceedings commenced on the evening of the first day by a reception of members at the beautiful and historic Hôtel de Ville at Brussels, the civic authorities being the hosts. The proceedings were of an exceptionally successful character. On the following morning, Tuesday the 21st ult., the first sitting for the reading of papers was held. The following is a list of the contributions submitted:—

(1) "On the Use of Caustic Lime in the Blast-Furnace," by Sir Lowthian Bell.

(2) "On the History of Crucible Steel," by R. A. Hadfield.

(3) "On the Coal-mining Industry of Belgium," by A. Briart, President of the Society of Engineers, Hainaut.

(4) "On the Iron and Steel Industries of Belgium," by A. Gillon, President of the Society of Engineers, Liège.

(5) "On the Influence of Aluminium upon the Carbon in Ferro-Carbon Alloys," by T. W. Hogg, of the Newburn Steel Works.

(6) "On the Manufacture of Open Hearth Steel," by J. A. Lencauchez, Paris.

(7) "On Colour Gauges for Carbon Determination," by W. G. McMillan.

(8) "On Electrical Power in Belgian Iron Works," by D. Selby Bigge.

(9) "On the Manufacture of Coke," by the late R. de Soldenhoff.

(10) "On the Iron Ores of the Mediterranean Seaboard," by Arthur P. Wilson.

The papers of Mr. Hadfield and the late M. de Soldenhoff were taken as read.

The members were received in the Burse des Métaux, where the sittings were held, by M. Gillon and M. Briart, on behalf of the reception committee, and the usual complimentary speeches having been made, business was commenced by the reading of M. Gillon's paper. The title sufficiently indicates the scope of this contribution, and it is evident that an abstract such as, in any case, we could give here would be quite inadequate to so large a subject. The same remark applies to M. Briart's paper, which followed. Both contributions are of considerable interest from an industrial point of view: the first because the Belgians are such keen and successful competitors of our own iron and steel manufacturers in some branches of the industry, and the second from the fact that the coal-mining practice of the Belgians is of a very advanced character. Coal is won in Belgium often under conditions of extreme difficulty, such indeed as would cause despair to mining engineers in our own more favoured land, though doubtless we should rise to the occasion were the necessity put upon us. The natural obstacles which the Belgian engineers are forced to meet have necessitated the highest skill in mining practice, and we cannot but look with admiration at the patience, ingenuity, and skill displayed in the working of many collieries of the country. Sir Lowthian Bell's paper followed. The controversy regarding the respective merits of using caustic lime or raw limestone in the blast furnace is one of much antiquity, and though Sir Lowthian's paper did not perhaps do very much in itself to determine the dispute, it may be said that the paper and the discussion together served to determine the lines upon which the controversy should be carried on. The author said that in the older type of blast furnace it was a desirable thing to calcine the limestone separately, but with the higher furnaces now in vogue there

was, on the balance, practically no advantage. In the discussion which followed, Mr. Charles Wood said that when iron ore and limestone were calcined together there was a distinct gain. We gathered from Sir Lowthian's reply to the discussion that he had not tried the plan Mr. Wood referred to—and which the latter had been following for twenty-five years—but that he would make further experiments on those lines. Perhaps the most striking feature in connection with this paper and discussion is its illustration of the value of societies of the nature of the Iron and Steel Institute. Here we have one practical detail which cheapens the cost of iron-making—at least, that is the opinion of a very competent ironmaster—in use for years, and it might have remained unknown to the majority of manufacturers had not the fact been elicited in this discussion. If Mr. Wood be right in his contention, he will doubtless receive confirmation from Sir Lowthian Bell at a subsequent meeting.

Mr. Hogg's paper followed, and in it were given the results of a large number of experiments, from which the author concluded that in the purer classes of iron the tendency of carbon to be retained in a combined state is prevented by the addition of 1 per cent. of aluminium, but curiously enough every increase above that percentage has an opposite tendency. It was also stated that the more rapidly cooled ferro-carbon alloys containing aluminium also contain a larger proportion of graphite. A short discussion followed the reading of this paper, and the meeting was then adjourned until the next day.

On the members reassembling on the following day, Wednesday, August 22, Mr. Selby Bigge's paper was first read. The author gave some interesting particulars of the progress that has been made in Belgium in using electricity as a means of distributing power in factories and workshops. The question has become one of commercial expediency, and the author boldly attacks it from this point of view, stating that his "whole contention in advocating electricity as the right and proper agent of operating new works, and as a means whereby old works can be remodelled, may be summarised by the one word 'economy.'" As an instance in point, he quoted the National Arms Factory at Herstal, near Liège. These works were recently founded to execute, in the first instance, an order for 200,000 rifles, the production being guaranteed at 250 rifles every twelve working hours. The Compagnie Internationale d'Électricité supplied the electric power installation, laying down thirteen motors, ranging between 16 and 37 horse-power, and giving a total of 260 horse-power. For the former size of motors they guaranteed a commercial efficiency of 87 per cent., and for the latter 89 per cent. The total power of the motors (260 horse-power) would therefore be obtained by 296·9 initial horse-power. There was a large amount of electric lighting to be done also, so that an engine and dynamo of 500 horse-power was installed. The ratio between the electric energy available and the energy transmitted to the shaft by the engine was guaranteed to be 90 per cent. The electric motors drive the line shafting of the machines, and the efficiency of transmission—that is to say, the ratio between the power available and the effective horse-power developed by the steam engine—is given by the product of three efficiencies, as follows: —90 per cent. for the dynamo, 98 per cent. for the conductors, and 87 per cent. for the motors = 76·6 per cent. The installation has now been running for three years without being the cause of cessation of work for a single minute.

It is a very difficult matter to form comparisons between the respective efficiencies of different methods of power distribution, and it may be pointed out that in the Herstal case the electric system does not appear to its greatest advantage, as the motors drive line shafting in place of being attached directly to the machines. There is no doubt, however, that a very strong case can be made out for electricity, and electrical engineers may look forward with confidence to a large extension of their field of activity in regard to power distribution.

The paper of M. Lencauchez dealt with a novel description of open hearth furnace in which jets of air and gas appear to be blown on the bath of molten metal to assist oxidation. The device did not receive much commendation in the discussion which followed the reading of the paper, but in the absence of illustrations referred to by the author, it was very difficult for those who had not had the advantage of seeing the furnace to follow the description.

The paper of Mr. McMillan, on colour gauges, was read in brief abstract, and Mr. Wilson's paper was also considerably curtailed in delivery, the time of the meeting having expired.

There were several excursions in connection with the meeting. The first, on the Tuesday afternoon, was to the Antwerp Exhibition, and on Wednesday evening members were received by the King of the Belgians, at the Royal Palace in Brussels. This was the chief feature of the meeting, the King receiving his guests in person, and apparently thoroughly enjoying the many conversations he had with the English metallurgists and engineers present. On the Thursday and Friday of the meeting, visits were paid to steel works, collieries, glass works, and engineering establishments. The last excursion on the list was to the important works known as the Société Cockerill at Seraing, near Liège. These works date from the beginning of the century, having been founded by a British subject, we believe a Scotchman. At present 5500 workmen are employed. According to particulars given to members in the shape of a handbill, there are five blast furnaces, an open steel plant, a basic steel plant, 250 coke ovens, 40 puddling, 15 reheating furnaces, 10 rolling mills, 3 foundries, 9 winding engines, 5 pumping engines, 4 blowing engines, 28 engines for rolling mills, 204 machine tools, 14 locomotives, and 184 steam boilers supplying 17,000 horse-power. The Company has also a shipbuilding establishment at Hoboken.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE meeting of the Association this year was a memorable one for physiology, since this subject was for the first time placed by the Council on an independent footing. This action of the Council has been amply justified by the success of the new Section I, there being a very representative attendance of English and continental physiologists, and great wealth of material for their consideration. The number of papers was so large that even when the sittings were extended to the final Wednesday morning, the business of the Section could only be got through with difficulty, and the opinion of all concerned was emphatic as to the high quality and great interest of many of the communications. In addition to the sectional meetings, advantage was taken of the presence of so many physiologists to dovetail a meeting of the Physiological Society into the proceedings; this was held on Saturday afternoon, when several interesting communications were made, and the meeting was followed by the dinner of the Society in Magdalen College, under the presidency of Prof. Burdon Sanderson.

The following summary will furnish a general account of some of the chief points in the many varied papers read before this Section:—

Thursday, August 9.—The proceedings opened with a communication by Mr. M. S. Pembrey, on the reaction of animals to changes of external temperature. The observed reaction was that of the production of heat, this being estimated by the amount of CO_2 discharged from the animal. Experiments upon the mouse were described, which showed that in proportion as the external temperature was lowered, the CO_2 output of the animal was rapidly increased (in one minute the increase amounted to 60 per cent. when the temperature fell from 33° to 17° C.), and concurrently with this increase the animal's muscular activity became far more vigorous. Experiments made upon the developing chick showed that up to the twenty-first day the effect of external cold was to decrease the CO_2 output, the chick in this stage behaving like a cold-blooded animal, but that a comparatively sudden change took place from this day onwards, the chick reacting like the warm-blooded animal previously referred to. This change in reaction is probably related to the development of the neuro-muscular mechanisms, and is undoubtedly influenced by the activity of the animal. Observations made upon newly-hatched pigeons showed that these birds, being more or less helpless when hatched, react for the first few days like cold-blooded animals, the output of CO_2 decreasing with a fall in the external temperature; it is probably for this reason that these young birds are kept warm by the parent until their muscular activity is more developed. The influence of the muscular activity upon the production of heat was further shown by details of observations made upon mice after section of the spinal cord, as well as during anæsthesia; in both cases the muscular paralysis was accompanied by a change in the reaction, which now resembled that of a cold-blooded animal.

Mr. Harris described the results of an investigation into the

muscular rhythm of voluntary tetanus in man. The muscle thrill during contraction was ascertained by recording the continuous contraction in a great variety of ways, as well as by ascertaining through a suitable telephone and microphone the muscle note. The observations confirmed in the main those of Schafer and of Griffith, and indicated that the thrill was due to a muscle vibration, the rate of which varied from 10 to 15 in the second, with an average of about 12 or 13 vibrations.

Prof. Allen gave a short demonstration of mirror writing.

Prof. McKendrick showed a phonograph, and demonstrated some of its effects to the audience. He explained the working of the instrument and the means by which he was now endeavouring to adapt it for such physiological investigations as those connected with the nature of the vowel and consonant sounds, and those in which it was desirable to obtain a permanent record of the cardiac and respiratory sounds. He then showed a new model, constructed by himself, to illustrate a possible mode in which the essential structures of the basilar membrane of the cochlea might be supposed to respond to compound tones. The model consisted of a glass box containing two cavities separated by a horizontal membrane and filled with liquid, the box communicating with the exterior by two apertures covered by membrane analogous to the fenestræ ovalis and rotunda. Two pistons rested by their bases on the horizontal membrane, and could be arranged of such size and weight that their periods of vibration should be as 1 : 2. In this scheme it was shown that in accordance with the rate of vibration communicated to the liquid the two pistons responded in variable amounts, thus analysing the wave in the liquid.

Prof. Gaule showed microscopic specimens and slides illustrating the remarkable changes observed by himself as following the section in the rabbit of the inferior cervical sympathetic ganglion or its branches. After a definite lesion these changes were found to be localised in particular muscles and special parts of the nervous system. Thus he found that after section of one branch of the ganglion the observed changes occurred in the rami communicantes, the lower cervical spinal cord, the anterior roots of the brachial plexus, and the biceps muscle of the fore-limb. He considered that the changes indicated trophic disturbances in the affected parts due to the lesion, and showed muscles in which the substance had suffered at various points the alteration in question.

Prof. Haycraft described an extensive research which he had made upon the development of the kidney, and showed a large number of micro-photographs to illustrate his remarks. The examination of continuous series of sections through this organ in different stages of its early growth, had convinced him that both the glomerular and tubular portions of the gland substance were formed as ingrowths from the same epithelium, viz. that lining the genito urinary canal. The view thus advanced as to the development of the kidney makes it analogous to that of other glands in opposition to former opinions.

Friday.—The Section commenced with the opening address of its President, Prof. Schäfer. This was followed by a communication by Prof. Heger, on the unequal diffusion of poisons into the organs of the body. In this paper an account was given of some of the chief means by which the organism was continually struggling against toxic substances, the principal objects to be effected being either the elimination of the unaltered poison, its neutralisation, or its destruction. The neutralisation might be either a true chemical combination, as in the case of CO_2, or a physical localisation in some special organs which could endure this excess, and so remove it from the rest of the organism. Thus morphine, if given in a series of increasing doses, accumulated in the liver, spleen, and marrow of the bones. In the case of microbic poisoning, Prof. Heger, whilst admitting that the constant multiplication of the microbes necessitated the destruction of the poison by phagocytosis, &c., pointed out that some such process of neutralisation as that just referred to was not only a possible but a probable antecedent to this destruction. Thus the liver cells and their secretion or extract appeared to have exceptional antitoxic properties. Experiments were quoted which showed the extent to which the frog's liver could not only retain and digest such poisons as hyoscyamine, but actually utilise the products derived from them as a food supply for the organ.

Mr. Hurst explained a new hypothesis as to the mode in which he conceived the organ of Corti and adjacent structures might be supposed to be affected by such alterations of pressure in the endolymph as must be produced by sound waves.

Prof. Schäfer showed photographs to illustrate a research made by Dr. Oliver and himself as to the functions of the suprarenal bodies. The photographs were chiefly those of tracings indicating the blood pressure, the heart beats, and the volume of the blood-vessels in such localised parts as a limb or the kidney. The injection of suprarenal extract was seen to cause a great rise of blood pressure, due not to any modification in the heart beat, but to the constriction of the blood-vessels, this constriction being dependent upon the integrity of the central nervous system.

Prof. Rutherford showed the result of an extensive series of observations in which the reaction time was measured for sight, hearing, and touch. The stimulus for the ear was the response of a telephone to a current, that for the eye the movement of an electro-magnetic signal, and that for the touch an induction current sent through the skin; the stimulus in all cases being made by the closure of a circuit. The response of the individual was the break of a current sent through a suitable electro-magnetic recording arrangement. By means of the pendulum a large series of records were obtained, in which as the initial starting-point occurred always at one place, and the different observations were arranged in series beneath one another, a comparison between different reaction times was rendered very conspicuous. He found that with eight intelligent men of ages varying from 19 to 62, the time for sight varied from $\frac{16}{100}$ to $\frac{22}{100}$ second, for hearing, $\frac{14}{100}$ to $\frac{19}{100}$, for touch, $\frac{14}{100}$ to $\frac{19}{100}$. The shortest reaction times were obtained when the response was that of the hand on the same side of the body as the ear or cheek which was stimulated.

Mr. D'Arcy Power showed a series of preparations of the conjunctival and vaginal mucous membranes taken from rabbits and guinea-pigs which had been subjected to mechanical and chemical irritation. Many of the epithelial cells presented appearances which were identical with those described as being parasitic when they were met with in cancer. The changes in the epithelium were summarised as a general vacuolation of cells; various forms of intracellular œdema; epithelial "pearls," collections of leucocytes, and the spaces left after these leucocytes had migrated. The series of preparations shown on the present occasion indicated that many squamous epithelial cells had the power of phagocytosis, for in no other way could the remarkable intracellular appearances be explained; cells were shown containing a leucocyte, and others containing a microcyte. Partial necrosis of the cell also took place as a result of irritation, and there was an invasion of large eosinophile cells into the conjunctival epithelium.

Saturday.—Prof. Hermann gave a most interesting communication upon the production of vowel and consonant sounds. His investigations were made by means of the phonograph, the excursions of the stylus being magnified, for which purpose a small mirror was attached to this part, and the character of its movement recorded by photographing the reflection in the mirror of a beam of light. Observations were also made in which a special telephone was introduced, thus rendering the excursions still larger. Numerous photographic records of various vowel and consonant sounds were exhibited, and each was seen to produce its own characteristic tracing. A matter of much theoretical interest in connection with the previous work of Helmholtz and others, was the character of the tracing when the same vowel sound was sounded in notes of different intensity but of similar pitch, or *vice versâ*.

Prof. Fredericq showed a new aerotonometer and gas pipette, which he had made in order to investigate the causation of the gaseous interchange between the blood and air of the lungs. By means of this apparatus the tension of the gases in these two media had been ascertained, and the results were laid before the Section. These furnished, in the author's opinion, material for criticising the view advanced by Prof. Böhr, that, as the Oxygen tension in the circulating blood often exceeded, whilst the CO_2 tension fell short of, that in the pulmonary air, the interchange could not be brought about in accordance solely with the laws of diffusion, but must be largely modified by the special vital activity of the lung epithelium. Prof. Fredericq's observations led him to believe that the data upon which Böhr's conclusions were founded, might be more or less incomplete owing to the time allowed for the contact between the blood and the air of the aerotonometer being too short in Böhr's apparatus for the correct determination of the tension of the O and CO_2 in that liquid. Fredericq's apparatus allowed of a long time, two hours, for the determination, and he had never obtained as low a tension of CO_2, nor as high a tension of O, in the blood as

Böhr had found. He therefore concluded that the diffusion hypothesis was adequate to account for the interchange. Dr. Haldane, replying to the above, pointed out that the criticism did not affect those experiments of Böhr's in which the ærotonometer CO_2 tension, although made initially higher than that in the pulmonary air, yet fell in the course of an experiment to a value much below the latter.

Mr. L. Cobbett and Mr. Melsome brought before the Section the results of an investigation on the production of local immunity through a localised specific inflammatory condition. It appeared from the authors' experiments that an attack of erysipelas localised to the ear of the rabbit conferred upon that organ an immunity against subsequent inoculation by the erysipelas organism so long as there was any indication of the inflammatory thickening occasioned by the first attack, and that the only consequence of this subsequent inoculation was a localised non-specific inflammation. The authors regarded this inflammation as the reaction of the affected tissues against the specific poison of the disease, since the absence of the specific *streptococci* indicated that this secondary effect was not due to the invasion of the tissues by the microbes. This view was confirmed by the fact that it was found possible to obtain similar inflammatory effects when the organisms themselves having been destroyed by heat the concentrated filtered culture was injected into the ear. Finally, since the parts which had previously suffered from erysipelas reacted more quickly and vigorously to the subsequent injection of the poison, it seemed probable that this non-specific inflammation was due to some adaptation of the tissues enabling them to respond with greater vigour, and thus more effectively, so that, as Metchnikoff and others have affirmed, the inflammatory process is from one aspect a truly protective one.

Mr. Lorrain Smith and Mr. Trevithick brought forward a research in many respects similar to the foregoing, but with one important difference, since the initial protective inflammatory process was brought about by a simple irritant. A sterilised liquid containing fine glass particles was injected into one pleural cavity of the rabbit and guinea-pig. The injection was followed by hyperæmia of the lung and by inflammatory exudation into the pleural cavity and the subjacent pulmonary alveoli. The subsequent injection of the *Bacillus pyocyaneus* was found to be inoperative as long as the injection was limited to the parts which were the seat of this primary inflammatory process; thus the inflammatory region was rendered immune, the localised immunity produced by the glass lasting as long as twenty-eight days.

Dr. Mann showed a series of microscopic specimens and microphotographs in which changes could be observed in various nerve cells as the result of their functional activity. The cells in question were those of the spinal cord, cerebellum, &c., particularly those associated with the functional activity of the retina, whilst the chief alterations were in the size and chromatin distribution of the cell nuclei. By bandaging one eye of an animal and then exposing it to light, Dr. Mann was able to distinguish an alteration in the size and staining of the cells upon the two sides in the following situations: the outer nuclear layer of the retina, the pyramidal cells of the occipital cortex, and the cells of the external geniculate body. The changes were most conspicuously shown both in the specimens and in the photographs.

At the meeting of the Physiological Society, held on Saturday afternoon, the following communications were made:—Dr. L. Hill showed the effect of gravity in altering the mammalian blood pressure, as illustrated by the remarkable rise in carotid pressure which occurs when the animal is changed from a horizontal to a vertical position with the head down, and the corresponding fall when the animal is similarly placed with the head up. Mr. Kent showed an organism which he believed might turn out to be the specific organism of vaccinia. Dr. Pavy showed a sugar of low reducing power which was obtained from the urine of an animal after the administration of large quantities of dextrose. Dr. Mott showed microphotographs of the medulla, cord, &c., after section of the gracile and cuneate nuclei of the monkey on one side of the medulla. The sections showed the degenerated arcuate fibres sweeping over to the opposite side of the medulla, and the degeneration in the fillet of the opposite side above the lesion. A remarkable point in connection with the changes was that the degenerated fibres could be traced up to the optic thalamus, but no farther, there being none in the internal capsule. He also showed microphotographs taken from sections of a cord in which a longitudinal section had been made in the lumbar region, the section being in the middle line. The sections showed degenerated fibres in both antero-lateral columns.

Monday.—Dr. Starling gave an account of the experiments which led him to believe that the flow of lymph from the thoracic duct was dependent upon the amount of the blood-pressure in the liver capillaries, and hence that the old mechanical theory of lymph formation was correct as regards this source of the lymph flow. He showed that obstruction of the inferior vena cava must raise the pressure in the portal capillaries, and that a similar result follows obstruction of the abdominal aorta. The flow of lymph which Heidenhain observed after these operations was not therefore necessarily due to secretory activity, but must occur in consequence of the pressure even if the permeability of the portal capillary walls remained unaltered. Similarly the injection of a large quantity of saline into the circulation (hydræmia) caused an increased flow in consequence of the purely mechanical rise of pressure in the liver capillaries, this rise being ascertained by taking simultaneous tracings of the blood pressure in the portal vein and the inferior vena cava. Many lymphagogues act by causing hydræmia, and in these the flow of lymph must be directly caused by the increase in the portal capillary pressure. That the lymph under these circumstances comes from the liver is shown by the absence of the flow from the thoracic duct when the lymphatics of the liver are ligatured. Some lymphagogues, the action of which was especially noted by Heidenhain (such as crayfish muscle extract), stimulate the flow of lymph without giving any evidence of increased pressure in the portal capillaries. The effect of these lymphagogues disappears after long continued obstruction of the aorta, and on this ground, since the liver lymph still flows, the author concludes that lymphagogues of this class act on other lymph sources than the liver, and probably in the main upon those present in the intestines.

Dr. Lazarus Barlow followed with some experiments upon the flow of lymph from the hind limbs. He found no increase in the flow when considerable though incomplete venous obstruction was maintained for one hour, whilst the specific gravity of the blood, muscles, and skin showed no evidence of any increased exudation. Such increased flow and exudation occurred, however, when, after thus damming up the katabolic products, the tissues under observation were supplied with blood through actively dilated arterioles. The dilatation, when caused by section of the sciatic nerve, led to no such increased exudation; hence he concluded that the demands of the tissue are an effective factor in lymph formation. When the arteries are actively dilated, the amount of exudation varies directly as that of the venous pressure; so that lymph formation, though not a purely mechanical process, is nevertheless simpler than a pure secretion, such, for instance, as exists in the salivary glands.

Messrs. Bayliss and Starling communicated the results of an experimental inquiry into the innervation of the portal vein. The method consisted in reading the pressure in the portal end of the cut splenic vein, which thus formed a side branch of the portal system. They found that the pressure rose when certain definite anterior roots were stimulated, these extending in the lower dorsal region from about the seventh to the tenth dorsal nerves; these, therefore, contain vaso-constrictor nerves for the portal system.

Mr. Bayliss gave a further communication upon vaso-dilator nerves. He showed that the fall of blood pressure which follows the excitation of the central end of the depressor nerve was accompanied by vaso-dilatation, this being evidenced in the case of the kidney by the simultaneous expansion of that organ, and in the case of the lower limbs by their increase of volume as indicated by the plethysmograph. As the vaso-constrictors leave the spinal cord by the lower lumbar roots, the section of the cord in the dorso-lumbar region will cut off the vaso-constrictors, and since, under these circumstances, the stimulation of the depressor still causes an increase in the volume of the limb, he was led to conclude (*a*) that the dilatation was really due to the increased activity of vaso-dilator centres, and not to the diminished activity of vaso-constrictor centres; (*b*) that the anterior roots by which the vaso-dilator nerves of the lower limbs leave the cord, extend higher into the dorsal region than is the case with the constrictor nerves. Corroborative experiments were carried out in which the cord was left intact, whilst the sympathetic, in which the vaso-dilators run, was divided. Under these circumstances no increase in the volume of the

limb accompanied the depressor excitation because the dilator supply was cut off.

Prof. Waymouth Reid gave an account of the alteration in the mucous membrane of the lateral pouches of the pigeon's crop, which were associated with the breeding season of the bird, and resulted in the formation of masses of fat-holding material constituting the so-called *pigeon's milk*. The secretion of this material is in its histological features analogous to the formation of sebum in the sebaceous glands, the fat being contained in cells which are cast off in masses from the mucous surface. The material is used for feeding the young pigeon, and when analysed is found to contain from 7 to 9 per cent of fat and 12 to 15 per cent. of proteids, the chief of which is a nucleo-albumin; unlike true milk it contains no sugar, but among its proteids is a caseinogen which clots with rennet with or without the addition of calcic chloride.

Prof. Dubois read a paper on the production of heat in hybernating animals, and brought forward the results of experiments made on the marmot in order to ascertain what circumstances influence the change which takes place at the end of hybernation. Section of the cord at the level of the fourth cervical nerve interferes with the waking from winter sleep, the delay thus caused being only partially due to the muscular paralysis and consequent inability to produce heat, since it appears that the integrity of the sympathetic system is an essential factor in the process. Further experiments seemed to indicate that the nervous control of the circulation was necessary for the waking up, and that the most important part of the circulation was that through the liver, which under the conditions produced by the section was inadequate for the supply of that organ. In consequence of this inadequate circulation the author believed that the proper functions of the liver were very much interfered with, and that in the normal animal these functions were at the moment of waking very actively carried on, particularly those by which glycogen is converted into sugar.

Prof. Haycraft showed some micro-photographs of collodion casts of muscle fibres in which the transverse striæ of the fibres were displayed. This communication was followed by one from Prof. Rutherford, who exhibited on the screen micro-photographs of muscle fibres both at rest and in contraction.

Tuesday.—A combined meeting of the Physical and Physiological Sections was held in the large theatre of the museum, when Prof. Lodge showed a number of experiments upon the reflection, polarisation, and refraction of Hertz waves, using as a detector for the presence of the propagated electrical disturbance an extremely sensitive cohesion tube. This contained fine particles in imperfect contact, and consequently offering considerable resistance to the passage of an electric current. The surging in the particles of an electric disturbance causes a better contact to be established, and the resistance consequently to be enormously diminished. Prof. Lodge followed this demonstration with a suggestion as to the mode in which it was possible to conceive of a reaction of the retinal structures to light vibrations. If we assume that the retinal elements constitute an imperfect conductor, and that a constant electromotive source is present in the retinal tissues, then it is not improbable that the light waves would cause a sudden diminution in the resistance of the elements, and allow the passage of a previously masked current; this current might excite the nerve-endings, and thus start the necessary nerve impulses. He pointed out that the coherer was acted on not only by the sudden commencement, but also by the sudden cessation, of the Hertz waves, and drew attention to Hering's view that white and black are both positive sensations, and both caused by retinal excitation. He stated that as regards colour, mathematicians only demanded a triple starting-point, and that since in Hering's theory three such independent factors were postulated, no objections to this theory could be raised on that score. The Young-Helmholtz theory seemed to him difficult to reconcile with the facts described by physiologists and observed by himself.

A discussion followed, in which several physiologists took part, the general tendency of the tone being that the suggestion must be capable of being applied to all living electromotive structures which display electrical changes when called into activity. It was also pointed out that the histological appearances were not at any rate opposed to Prof. Lodge's suggestion.

Prof. Osborn described a modification of Golgi's method used by Mr. Strong, of New York, and showed beautiful photographs of nerve cells from various parts of the central nervous system treated in this way.

Dr. Haldane brought before the Section the evidence which had led him to the conclusion that in the recent colliery explosion in South Wales, and probably in most previous ones, the cause of death by suffocation was the deficiency of oxygen in the mine due to its displacement by the products of the explosion, *i.e.* after-damp. Suffocation by deficiency of oxygen occurs when the respired air contains less than 8 per cent. of O; it is ushered in by an extremely sudden attack of muscular paralysis, so that there is but little warning of the danger when air is inspired deficient in O, and little chance of escape owing to the muscular failure. Suffocation through excess of CO_2 is quite different, as it is preceded by gradual respiratory distress in which the neuro-muscular system is aroused to greater activity. In addition to the deficiency of O, the poisonous "after-damp" contains often at least two noxious gases in fatal percentage, these being CO and H_2S. The most effective method of fighting one's way through after-damp seemed therefore to be one which aimed at restoring to the inspired air an adequate quantity of oxygen, and this the author thought might be effectually done by suitable portable cylinders of this gas.

Mr. W. G. Smith brought forward some observations illustrating some of the mental conditions which influence the association of ideas, *i.e.* memory. Experiments were made as to the effect upon such association of contemporaneous nervous activities other than those which presumably were more or less directly involved. Thus the power of recollecting a given arrangement of letters which had been exposed before the eye for ten seconds was found to be modified by the person under observation having to carry out simultaneously any one of the following among other operations during the period of exposure: tapping rhythmically on the table with the forefinger; speaking a simple syllable over and over again; carrying out a simple sum in addition in an audible voice. In all cases the effect was to confuse the recollection, the degree of confusion being greatest in the last two described instances.

Wednesday Morning.—Profs. Gotch and Lodge demonstrated the method employed by them in order to study the physiological effects produced by rapidly alternating currents of high intensity. They first showed that a nerve muscle preparation from the frog, if held in the neighbourhood of a friction machine to the poles of which were attached Leyden jars, responded by a single contraction whenever a spark passed between the knobs of the machine. Since there was no connection, except an air one, between the preparation and the machine, it was evident that the response was due to the preparation being in the line of force which spreads out from the knobs, and that when the spark passed, the sudden equalisation of these effects must be accompanied by a surging to and fro in the exposed nerve; the sudden character of this excites the tissue. They then showed the following experiment:—

A looped circuit was arranged connecting the two Leyden jars together, but leaving them attached to the friction machine; the end of the loop was connected to the earth, this being essential to avoid all static effects. Two wires were joined, one to each side of the loop, and the ends placed so as to embrace the exposed nerve of a nerve muscle preparation midway between the central end and the muscle. The upper end of the nerve was now brought into contact by means of other separate electrodes with an induction apparatus, and was excited every four seconds by a minimal excitation. On working the friction machine, and passing the strong rapidly-oscillating currents of the Leyden jars through the preparation, it was observed that only when the spark of the friction machine was extremely intense did the preparation respond by a contraction to these rapidly alternating currents, and that the sole effect of rather feebler alternating currents was to so alter the nerve that it ceased for a brief period to transmit the nerve impulse evolved by the constant rhythmical stimulus at the central end. The passage of these currents thus seems to produce a temporary paralysis of the nerve without causing excitation, acting thus like pressure or cold.

Prof. Engelmann described a new kymograph and polyrheotome, and exhibited tracings obtained with the instrument, which showed the great accuracy of the apparatus. The recording surface was driven by means of a weight which was so contrived as to ensure that in each experiment the same velocity should be reached before the weight ceased to act, and the subsequent revolution rendered practically uniform.

Mr. G. J. Burch showed a series of photographs of the excursions of a very sensitive capillary electrometer when projected on to a rapidly travelling plate and actuated by speaking into a telephone placed in the circuit. The excursions formed the basis for calculations of the E.M.F. of such telephone currents as are produced by the sounds of ordinary conversation; this varied from ·05 to ·1 of a volt, but with louder sounds might be sufficient to produce electrolysis. Photographs were shown which demonstrated that the instrument used could respond to changes of potential difference when these occurred one after another at a rate of nearly 3000 double vibrations in one second. The effect of the sounds of certain vowels and consonants were shown, such as *ah*, *ee*, *z*, and *r*. In each case the fundamental tone of the voice and some of its harmonics combined to give a characteristic electrometer excursion with higher rapid vibrations superimposed upon it. These in the case of *z* were just visible under a lens, and appeared to have a rate of 3000 in one second. Photographs were also shown of the characteristic excursion caused by the pronunciation of the words, "Pop, pop," and "Dod, dod," the difference between the labial and the dental being well marked. Finally another series of photographs was exhibited which demonstrated that when electrolysis occurs in the electrometer, and the evolution of the gas recorded on the travelling photographic plate, this evolution is seen to take place without any measurable delay the instant the electrolysing current commenced.

BRITISH ASSOCIATION CONFERENCES OF THE DELEGATES OF THE CORRESPONDING SOCIETIES.

THE meetings of the Conference of Delegates were held at the New Examination Schools. Forty-two societies nominated delegates to represent them at the Conference.

FIRST CONFERENCE, AUGUST 9.

The Corresponding Societies' Committee was represented by Prof. R. Meldola (chairman), Prof. T. G. Bonney, Sir John Evans, Sir Douglas Galton, Dr. Garson, Mr. Hopkinson, Mr. Cuthbert Peek, Sir Rawson Rawson, Mr. Symons, Mr. Topley, Mr. Whitaker, and Mr. T. V. Holmes (secretary).

The Chairman remarked that this was their tenth Conference. Hitherto the reports of these Conferences had always been a year behind, as regards their publication in the British Association volume; the report of the Conference held at Edinburgh in 1892, for example, appearing in the volume giving an account of the proceedings at Nottingham in 1893. Steps had been taken to prevent this delay in future. They had also taken a new departure in announcing beforehand that some special subject would be discussed at the Conference. On that occasion they had been fortunate enough to secure the attendance of Mr. Cuthbert Peek to open a discussion on Local Museums.

Mr. Cuthbert Peek dealt with the subject under the following headings:—

(1) Methods of registration and cataloguing.

(2) The protection of specimens from injury and dust.

(3) The circulation of specimens and type collections for educational purposes.

(4) Central referees for nomenclature and classification.

(5) The most satisfactory methods of making museums attractive.

(6) Museum lectures and demonstrations.

(7) The relations between museums and County Councils.

(1) For small museums he thought a card catalogue was the best. Sectional letters should distinguish the various classes of objects. Each specimen, when received, should have a number under the letter of the section assigned to it, painted on the specimen. It was a good thing to have the dimensions of the specimen, with a rough outline of it, on the back of the card.

(2) Every closed case was acted upon by changes in the pressure of the atmosphere, so that it drew in and gave out air and dust with every change of pressure. It was desirable to admit air into each case by means of an opening filled with cotton-wool, or some similar material, so that the air entering might be filtered.

(3) At Liverpool a system had been elaborated by which loan-collections were prepared and circulated among a large number of schools. Each collection contained some special class of objects, such as food products, woods, &c. Those wishing to organise a plan of this kind should consult a paper by Mr. J. Chard, in the Report of the Museums' Association for 1890.

(4) The average curator of a small museum was often in difficulties as to the correct names of certain specimens. An organisation of specialists who would, for a small fee, allow specimens to be forwarded to them for identification, would be of the greatest use.

(5) While there were many well-arranged and attractive museums, there were others dusty, with labels illegible or invisible, which were almost unvisited and unknown. The English as well as the Latin names of specimens should be given. Much might be done to exhibit the variations of structure in creatures of different families or genera. Thus, in the Natural History Museum, South Kensington, there had recently been placed the skeletons of a man and of a horse, both in the attitude of running, so that the relations of the two, bone for bone, could be distinctly seen. The surgical, ordinary, and veterinary names of the bones were added.

(6) It was extremely difficult to make a museum demonstration useful to more than about a dozen persons. One experienced demonstrator had suggested that a lecture should be given in an ordinary lecture-room, illustrated by specimens, &c., to the whole of a large gathering, and a case-demonstration afterwards to the few seeking further information. The demonstrator should be placed on a temporary stand, so that he might see, and be seen by, his audience.

(7) It had always appeared to him that demonstrations in museums should take a very prominent part in technical instruction, and he had been surprised that so little aid had been given by County Councils to museums. Having sent out a circular to County Council Technical Education Committees, he had found that local museums and free libraries had been assisted in only nine cases. From some counties no information had yet been received, but it would appear from the answers received that there was no insuperable obstacle to the application of money intended for technical education to the development of museums.

In conclusion, Mr. Peek drew attention to the magnificent museum founded at Oxford by General Pitt-Rivers, the arrangement of which was unique.

The Chairman thought they were greatly indebted to Mr. Peek, and invited discussion.

Sir John Evans said that Mr. Peek had left but little for any one to add. He approved of the card catalogue, but thought that the American system of having a perforated card through which a wire passed might perhaps be preferable. He would be glad to know the best way of keeping a cabinet free from dust. He had tried a lining of cotton-wool, but did not think the result perfectly satisfactory. As regards referees for nomenclature and classification, he would suggest the keepers of the various departments of the British Museum, who would always give prompt and valuable assistance.

The Rev. O. P. Cambridge, having a large collection in spirits of wine, had found that the best place for the labels was inside the glass jars, not outside. The writing should be with a pencil.

Sir Rawson Rawson had not always found pencil-marks indelible; and the Rev. O. P. Cambridge added that the pencil should be neither very hard nor very soft.

Dr. Garson could corroborate what had been said as to the advantages of using pencils in spirit preparations. Mr. Gray remarked that variation in the aspect of a museum constituted a most important element of attraction. The circulation of specimens tended, in itself, to make a museum attractive.

Mr. T. W. Shore hoped that Conference might do something towards obtaining aid for museums from County Councils. It was clear that grants could be made by County Councils to defray the expense of lectures and demonstrations in museums.

Mr. Sowerbutts remarked that though County Councils might be subject to the Government auditor, boroughs were not; and Mr. Kenward said that at Birmingham the Corporation had established a museum and art gallery without any help from the County Council.

Mr. T. V. Holmes had in his hands a letter from Mr. W. Cole, secretary to the Essex Field Club, who was most intimately acquainted with technical education as it existed in Essex. Mr. Cole's experience had given him a very low notion

of the efficacy of mere lecturing. A lecturer brought specimens with him, but with the departure of the lecturer the specimens also departed. What was wanted was (Mr. Cole thought) a permanent central museum continually sending forth loan collections to the remoter districts, the collections being allowed to remain a certain time after the lectures illustrated by them had been given. He did not think County Councils should have the entire control of museums, as that would greatly diminish the interest taken in them by the naturalists and field clubs to whom they usually owed their existence. But a grant from the County Council would give a permanence to a museum which would immensely increase its efficiency in every way.

After some discussion, in which Dr. Brett, Sir Douglas Galton, Mr. Gray, Sir John Evans, Mr. Cushing and Mr. Whitaker took part, the following resolution was proposed by Sir Douglas Galton, and seconded by Dr. Brett :—

"That in the opinion of this Conference it is desirable that local natural history societies, and those in charge of local museums, should place themselves in communication with the Technical Instruction Committee of the county or borough in which they are placed, with the view of obtaining pecuniary grants towards extending technical knowledge by means of lectures or by demonstrations in museums."

Mr. Coates stated that at Perth they were building a large addition to their museum, and had obtained a grant from the County Council on condition that they provided specimens suitable for agricultural teaching.

Mr. Elworthy said that a difficulty felt by many had not been touched upon. They needed the services of an expert who would visit a museum and pronounce with authority, "this is rubbish," in the case of worthless specimens. A secretary would seldom venture to get rid of rubbish on his own responsibility.

Sir John Evans thought the opinion of the secretary should be deemed sufficient.

The Chairman then put the resolution to the meeting, and it was unanimously adopted. On asking if any delegates had any other remarks to make,

Mr. Seward, of Cardiff, was anxious to know, if possible, what things bought for a museum in order to make it more useful and attractive to the poorer classes might be legally purchased under the Act.

Sir John Evans said that it seemed to him that the last resource in these cases was the Science and Art Department at South Kensington.

The Chairman thought the Conference could not possibly attempt to decide the point raised by Mr. Seward. He felt sure that all present were most grateful to Mr. Peek for having opened this discussion on museums, which, he believed, would lead to most useful results.

SECOND CONFERENCE, AUGUST 14.

The Corresponding Societies' Committee was represented by Prof. R. Meldola (chairman), Dr. Garson, Mr. Hopkinson, Sir Rawson Rawson, Mr. Symons, Rev. Canon Tristram, Mr. Whitaker, and Mr. T. V. Holmes (secretary).

The Chairman hoped that delegates would do their best to further the resolution passed at their last meeting, with regard to local museums.

SECTION A.

Meteorological Photography.—Mr. Clayden stated that a sufficient collection of photographs had been received, except that he would be glad of photographs of lightning showing anything abnormal. Sometimes he read of the remarkable effects of a whirlwind in some district when it was too late to obtain photographs of its results. In such cases he would be glad if the secretary of some local society could get photographs taken at once, and send them to him before it was too late. In reply to Sir Rawson Rawson, he said that he had seen the photographs of storms and lightning exhibited by the Royal Society, and believed he had many of them.

Mr. Symons remarked that much help could be given by local societies if they were to send reports in.

Earth-tremors.—Mr. Davison said that in the last report of the Earth-tremors Committee there was a description of a bifilar pendulum invented by Mr. Horace Darwin. It had also been described in NATURE for July 12. It was especially desirable that instruments for registering earth-tremors should be placed along the course of great lines of fault (dislocations of the strata).

Mr. Horace Darwin then explained the construction of his bifilar pendulum for registering earth-tremors. It was not, he said, affected by the rapid, complicated movements which took place during an earthquake, nor by the slight tremors caused by passing carts or trains. But extremely slight movements of the kind which would make a factory chimney lean to one side would be registered.

Mr. Symons, as chairman of the Earth-tremors Committee, explained how the work of the Committee had grown, and in what respect it needed additional help. A series of pulsations which had been recorded by an instrument placed at the bottom of one of the deepest mines in the district of Newcastle-on-Tyne had been traced to two causes—the gradual settlement of the ground in consequence of the removal of the coal, and the beating of the waves on the coast. They had since been looking for traces of earthquake tremors. Mr. Davison on one occasion watched his instrument for some time, as he found pulsations were taking place. They turned out to have been produced by the earthquake then going on in Greece. They wanted information as to the changes going on in connection with the faults in geological strata, and, if possible, to get records of the alterations in the earth's crust caused by tidal waves. The work was then going on at Birmingham under Mr. Davison, but they were anxious to have instruments established in other parts of the British Isles. In answer to Mr. Tiddeman, Mr. Symons said that an instrument could be placed on the floor of a cellar. Mr. Horace Darwin had kindly undertaken to explain its mechanism at the close of the Conference.

The Chairman hoped that some of the corresponding societies would have something to report on this question next year.

SECTION B.

Pollution of Air in Towns.—Dr. G. H. Bailey said that for three or four years they had been engaged in Manchester, in connection with the Manchester Field Naturalists, in examining the air of towns. The amount of pollution and the amount of the death-rate varied together. They had almost perfected a method for determining the amount of sulphur compounds in the air, and one for measuring the amount of sunlight in towns. Their work had been chronicled in the *Journal* of the Manchester Field Naturalists for 1893.

Mr. Slater made a few remarks on the effects of smoke on plants, and the Chairman added that cryptogams and lichens were once common on trees in Epping Forest. London had now approached too near for them to flourish.

SECTION C.

Mr. Whitaker (representing Section C) said that he would first refer to coast-erosion. The final report on this subject would be made, he hoped, next year. The subject would then be handed over to the local societies, and those which had coast borders could continue the work by recording changes on six in maps. As regards the Committee on the Circulation of Underground Waters, its final report would also be made next year. In this case, also, the local societies could continue the investigation. It had been suggested that the twenty reports should have their contents arranged topographically, and that if then published, as a volume of 250 to 300 pages, many local societies might be glad to purchase it.

Erratic Blocks.—Mr. Murdoch regretted that the labours of the Erratic Blocks Committee were confined to England and Ireland. The work in Scotland had not been so nearly finished as was commonly supposed. Mr. Gray said that in Ireland they had issued their first Report on Erratic Blocks.

Prof. J. F. Blake stated that he was engaged in examining the microzoa of clays, especially of Jurassic clays, and would be glad if members of the corresponding societies could send him samples. He would gladly report to senders on the general character of these clays and their microzoa. He might take that opportunity of telling the delegates that unless he could obtain more support for the *Annals of British Geology* he could no longer afford to publish it.

Mr. Whitaker hoped that Mr. Blake's remarks would prevent the cessation of that most useful work.

Geological Photographs.—Mr. Jeffs said that the committee had received 1055 photographs, and had passed a resolution recommending the Council of the British Association, whose property the collection was, to deposit it in the Museum of Practical Geology, Jermyn Street, London.

SECTION E.

Mr. Sowerbutts said that the Manchester Geographical Society had come to the conclusion that geography would never be taught satisfactorily in primary schools unless it was made a compulsory subject. Progress had been made in some primary schools by the institution of school-museums. It was a singular fact that at an examination in geography of the primary schools of Cheshire, Lancashire, and Yorkshire, the girls had won all the prizes in Yorkshire, and the boys in Lancashire. His Society had for the last two or three years published an analysis of the chief geographical papers which had appeared in English and foreign journals.

SECTION H.

Ethnographical Survey.—Mr. Brabrook remarked that during the past year their list of suitable villages had been considerably increased, and now numbered 367. At Ipswich a sub-committee had been formed to assist them, and at Liverpool the keeper of the museum had given most valuable help. In Wales their sub-committee had met and had done good work, and the same remark might be made of Ireland. In Scotland they had a promise of assistance from the Glasgow Archæological Society. They had been told that their instructions about photographing were too minute, but they had been drawn up by Mr. Francis Galton with reference to his system of composite photographs, and any departure from them would make the application of that system comparatively difficult.

Mr. Sowerbutts stated that old people in his district objected to be photographed and measured.

Dr. Garson said that as regards photographs it was not necessary to get all the appliances Mr. Galton had mentioned. It was desirable to have a seat which could be raised or lowered like a piano-stool, so that each person might have his head in the same place, whatever his height might be. It was well, also, to have chalk lines on the floor at right angles to each other, the sitter being directed to look along either one line or the other. They did not want measurements of people more than fifty years old.

Mr. Brabrook added that a set of instruments for measurements might be had for £1 6*s.*, and a more expensive set for £3 3*s.* And Dr. Garson remarked that the cheaper set was quite good enough.

A vote of thanks to the chairman closed the proceedings.

SCIENTIFIC SERIALS.

Proceedings of the Edinburgh Mathematical Society, vol. xii. (Williams and Norgate, 1894.)—The geometrography of Euclid's problems, by Dr. J. S. Mackay, is a modification of M. E. Lemoine's La Géométrographie ou l'art des constructions Géométriques (the subject of two memoirs read at the Oran (1888) and Pau (1892) meetings of the French Association for the Advancement of the Sciences), and an application of it to the problems in the first six books of Euclid's "Elements." The restrictions are those of Euclid, viz. that the constructions should be effected by means of the straight-edge and compasses only. It is an interesting introduction of M. Lemoine's methods to English readers. The same author contributes formulæ connected with the radii of the incircle and the excircles of a triangle. This is on the lines of the work we recently noticed by the same writer (vol. i. *Edin. Math. Soc. Proceedings*). It is founded upon a table given in the *Lady's and Gentleman's Diary* for 1871. Nearly all of the eighty formulæ are assigned to the authors who first published them: possibly those unassigned are due to Dr. Mackay himself. M. Paul Aubert, in his "Coordonnées Tangentielles," applies them to the discussion of a number of general problems relating to surfaces of the second order.—Dr. Sprague writes on the geometrical interpretation of i^i; his investigation was suggested by a result given in Hayward's "Vector Algebra and Trigonometry."—Mr. G. A. Gibson, in a proof of the uniform convergence of the Fourier Series, with notes on the differentiation of the series, discusses a point which has not, apparently, been considered in the English text-books.—In addition to the above papers there are several short notes: Prof. Crum Brown gives an abstract of a paper (to appear) in the *Transactions* of the Royal Society of Edinburgh, on the division of a parallelepiped into tetrahedra; notes on factoring, J. W. Butters; on a problem in tangency, G. E. Crawford; on certain maxima and minima, G. Duthie; on solutions of certain differential equations, F. H. Jackson; on E. Carpenter's proof of Taylor's theorem, R. F. Muirhead; notes on the number of numbers less than a given number and prime to it, and on the pedal triangle, Prof. Steggall; five notes, viz. two circular notes, geometrical note (ii.), two triplets of circum-hyperbolas, three parabolas connected with a plane triangle, and notes on an orthocentric triangle, R. Tucker; and a note, by W. Wallace, on a third mode of section of the straight line. Of the other communications that were made to the Society during the session the titles only are given. A list of members and of the presents made to the library close the volume, which contains a good deal of matter of interest to mathematical teachers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 7.—"On the Recurrent Images following Visual Impressions." By Shelford Bidwell, F.R.S.

The earliest recorded observation of a certain curious phenomenon associated with optical after-images is that of Prof. C. A. Young, who published a note on the subject in the year 1872, and proposed that the phenomena should be called "recurrent vision." (*Phil. Mag.* vol. xliii. 1872, p. 343). He noticed that when a powerful Leyden jar discharge took place in a darkened room, any conspicuous object was seen twice at least, with an interval of a little less than a quarter of a second; often it was seen a third time, and sometimes even a fourth.

A few months later an account of two experiments on the same subject was published by Mr. A. S. Davis. (*Phil. Mag.* vol. xliv. 1872, p. 526). In the first, a piece of charcoal, one end of which was red-hot, was waved about so as to describe an ellipse or circle a few inches in diameter. A blue image of the burning end was seen following the charcoal at a short distance behind it, the space between the charcoal and its image being absolutely dark. The other experiment was made with a piece of apparatus resembling a photographic instantaneous shutter. The shutter was interposed between the observer's eye and the sky, and was covered with pieces of coloured glass, through which momentary flashes of light were allowed to pass. It was found that each flash was, after a short interval, generally succeeded by a recurrent image, the colour of which was nearly complementary to that of the glass.

In 1885 the author called attention to a very simple and effective method of exhibiting a recurrent image (NATURE, vol. xxxii. 1885, p. 30). If an ordinary vacuum tube, illuminated by an induction coil discharge, is made to rotate slowly upon a horizontal axis fixed at right angles to the middle of the tube, the tube is seen to be followed at a distance of a few degrees by a ghost-like image of itself, the ghost exactly imitating the original in form, but having a uniform steel-grey colour. In the same paper the following observation is noted:—"The vacuum tube being at rest in a feebly lighted room, I concentrated my gaze upon a certain small portion of it while the discharge was passing. The current was then interrupted, and the luminous image was almost instantly replaced by a corresponding image which appeared to be intensely black upon a less dark background. After a period, which I estimated at from a quarter to half a second, the black image again became luminous; this luminous impression lasted but for a small fraction of a second, and the series of phenomena terminated with its disappearance . . . . It was also found desirable to make the preliminary illumination as short as possible, a single flash being generally sufficient to produce the phenomena." The following comment was added:—"The series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character. Abnormal darkness follows as a reaction after the luminosity, and again after abnormal darkness there is a rebound into feebler luminosity."

The subject has recently attracted much attention in connection with the experiments of M. Aug. Charpentier. The account of them given by M. Charpentier in a paper on "Retinal Oscillations"[1] is briefly as follows:—If a black disk having a white sector is illuminated by a strong light, and slowly turned round while the observer's eye is fixed upon its

[1] "Oscillations rétiniennes," *Comptes Rendus*, vol. cxiii. 1891, p. 147. See also "Réaction oscillatoire de la Rétine," *Arch. de Physiologie*, 1892, p. 541.

centre, there appears upon the white sector, near to its leading edge, a well-defined dark band, which is separated from the black ground of the disk by a similar white band. The angular extension of the dark band increases with the speed of rotation, so that it always takes the same time to pass over a fixed point on the retina; it begins about one-sixty-fifth or one-seventieth of a second after the first passage of the white, and lasts sensibly the same time. He goes on:—"The dark band is in fact only a kind of reaction of the retina after the luminous excitation, a reaction which can be demonstrated in a totally different manner. I have found that if an instantaneous luminous excitation is produced in complete darkness the sensation appears to be reduplicated; shortly after its first generation it seems to disappear, and then manifest itself again. This is the case, for example, when a single discharge from a Ruhmkorff coil is passed through a Crookes or Geissler vacuum tube, or simply, but less obviously, through the air. . . . . There is, then, in this last experiment, as in the first, a negative reaction of the retina under the influence of excitation. . . . . It would be difficult, and in any case premature, to indicate the cause of this phenomenon, but it may fairly be characterised as the result of a retinal oscillation set up under the influence of the beginning of the luminous excitation."

The present paper deals partly with the colours of recurrent images under different conditions, and partly with the reaction attending the early stages of a luminous impression as noticed by Charpentier.

In the observation of the recurrent images set up by the action of light of different colours, the author began, like Mr. Davis, by using coloured glasses.

A metal disk, about 8 cm. in diameter, was arranged so as to rotate slowly and steadily about its centre in front of the condenser of a projection lantern. Near the edge of the disk was a circular aperture about 0·5 cm. in diameter, the image of which was focussed upon a distant screen. A plate of coloured glass was placed before the projecting lens, and thus was obtained a small coloured disk of light, which described a circular path upon the screen. The coloured disk was, in most cases, seen to be followed at an interval of a few degrees by a ghost of the same size and shape, but of feebler luminosity, and of a hue which varied more or less with the colour of the glass employed. With white electric light the colour of the ghost was violet.

This method of experimenting was, however, found to be unsuited for the purpose in view, and it is mentioned only on account of the facility which it affords for exhibiting the phenomenon to a large number of persons. To obtain results of any value, it was necessary to employ the simple colours of the spectrum.

In the arrangement finally adopted, light from a selected portion of a spectrum was projected upon a small mirror, to the back of which was attached a horizontal arm, not quite perpendicular to the mirror: the arm was rotated by clockwork, and the reflected beam of light was received upon a white screen, forming a coloured disk about 1·5 cm. in diameter, which revolved in a circular path having a diameter of 30 cm.

When the mirror turned once in 1½ seconds the ghost or recurrent image appeared about 50° behind the coloured disk, the corresponding time interval being one-fifth of a second. The ghost appeared to be circular in form, its diameter being generally rather less than that of the original. The colours of the recurrent images, as specified below, have all been observed by several persons, and, except as to those at the extreme limits of visibility, all the observations were in agreement.

Spectrum colours.	Recurrent colours.
Extreme violet... ...	No perceptible image.
Middle violet	A pale image, variously described as grey, yellow, and greenish-yellow.
Dark blue	Feeble violet.
Light blue	Brighter violet.
Middle green	Bright violet. The image is more conspicuous with green light than with any other.
Greenish-yellow ...	Blue.
Orange-yellow... ...	Bluish-green.
Orange	Dark bluish-green.
Orange-red	Very dark bluish-green.
Red	No image at all, however bright the red was made.

A complete small spectrum, revolving parallel to itself in a circle about 1 metre in diameter, was followed by a ghost which corresponded to the portion of the spectrum comprised between the orange and the beginning of the violet. The *whole* of this ghost was of a violet hue: no trace whatever of yellow or greenish-yellow could be detected at the more refrangible end, nor of blue or bluish-green at the other.

From other experiments it appeared probable that the blue and bluish-green recurrent colours apparently observed when the yellow and orange portions of the spectrum are tested separately are due merely to an effect of mental judgment, and not to any cause of a physiological nature.

Four independent facts are consistent with the conclusion that luminous recurrent images are due to a reaction of the *violet* nerve fibres only.

(*a*) With white light the recurrent colour is violet.

(*b*) In the recurrent image of the complete spectrum no colour but violet can be detected.

(*c*) A pure red light, however intense, gives no recurrent image. (It is generally supposed by the supporters of the Young-Helmholtz theory that red light has no action upon the violet nerve-fibres.)

(*d*) The apparently blue colour of the ghost of simple spectrum yellow is just as well produced by a compound yellow consisting of green and red, the latter of which is inert when tested separately.

The path of the revolving spot of light is generally marked by a phosphorescent track, which, when the rate of revolution is not less than one turn in 1½ seconds, often forms a complete circle. The trail is due to the usually feeble continuation of the after-image, of which the bright initial stage constitutes the recurrent image.

In the experiment next to be described, the Charpentier effect and the recurrent image are made to exhibit themselves simultaneously.

Two blackened zinc disks, 15 cm. in diameter, from each of which two opposite quadrants were cut out, were mounted in contact with each other on a horizontal axis, driven by clockwork, and making one turn in 1½ seconds. By slipping the disks over one another round their centres, opposite open sectors might be obtained, of any aperture from 0° to 90°. The apparatus was set up opposite a box containing a 32-candle power incandescent lamp, with a variable resistance in the circuit, the side of the box between the lamp and the disks being covered with a sheet of ground glass.

The sectors being in the first place opened as widely as possible, Charpentier's dark band was easily seen upon the illuminated background.

The sectors were then gradually closed up, until the posterior edge of the dark band approximately coincided with that of the sector. When this was accomplished, it was found that the arc of the open sector was equal to about $\frac{1}{32}$ part of the whole circumference. The dark reaction, therefore, ceased in ($\frac{1}{32}$ of 1½ seconds =) $\frac{1}{21}$ second after the first impact of the light upon the eye.

For more readily demonstrating the succeeding phenomena, it was found convenient to again open the sectors a little, so that they covered an angle of about 10° or 12°. Resuming the observation, it was seen that the posterior edge of the open sector was bordered by a luminous fringe due to persistence. A little beyond the termination of the fringe there appeared an intensely black radial band, estimated to cover a space of from 3° to 4°, and distinguishable even upon the black ground of the metal disk, though it is shown far more conspicuously upon a translucent disk made of stout writing-paper with a sector cut out. Lastly, after another interval of perhaps 35° or 40°, came the luminous recurrent image, which, with the yellowish light of the incandescent lamp, appeared to be of a blue colour.

This method of observation revealed one other point of interest, which seems hitherto to have escaped notice, though it is evident enough with a Charpentier disk, when once attention has been directed to it. The average illumination of the bright band intervening between the dark band and the leading edge of the sector is much more intense than that of the other portion of the sector. Moreover, it is not uniform, but increases, gradually at first, and very rapidly at last, from the leading edge up to the dark band. In fact when the light used is not strong, the luminous margin of the bright band is a far more conspicuous object than the dark band itself: it appears to glow almost like a white-hot wire.

Charpentier states that, under favourable conditions, he has been able to detect the existence of a second, and even of a third, dark band of greatly diminished intensity, though he adds that the observation is a very difficult one. What is probably the same effect in a different form can, however, be shown quite easily in the following manner:—

In a blackened zinc disk 15 cm. in diameter, there were cut two opposite radial slits, about 0·5 mm. in width. The disk was rotated at the rate of one turn per second in front of a sheet of ground glass, behind which was an incandescent lamp. The glass was covered with opaque paper, in which a circular opening was made of slightly less diameter than the disk. The disk was placed opposite this opening, and no light reached the eye except such as passed through the two slits. When the disk was observed from a distance of about $1\frac{1}{2}$ metres, the eye being fixed upon its centre, each slit appeared to give four (or possibly five) luminous images, arranged like the ribs of a partly opened fan. The images were distinctly separated by dark intervals near the circumference, but overlapped one another towards the centre. The leading image was naturally the brightest, each consecutive image being considerably weaker than its precursor. All had the same tone of colour, namely, that of the yellowish-light given by the electric lamp. The usual blue recurrent image could also be seen following the images of the radial slits, at an angle of about 80°.

It appears, then, that when the retina is exposed to the action of light for a limited time, the complete order of visual phenomena is as follows:—

(1) Immediately upon the impact of the light there is experienced a sensation of luminosity, the intensity of which increases for about one-sixtieth of a second: more rapidly towards the end of that period than at first.

(2) Then ensues a sudden reaction, lasting also for about one-sixtieth of a second, in virtue of which the retina becomes partially insensible to renewed or continued luminous impressions. These two effects may be repeated in a diminished degree, as often as three or four times.

(3) The stage of fluctuation is succeeded by a sensation of steady luminosity, the intensity of which is, however, considerably below the mean of that experienced during the first one-sixtieth of a second.

(4) After the external light has been shut off, a sensation of diminishing luminosity continues for a short time, and is succeeded by a brief interval of darkness.

(5) Then follows a sudden and clearly-defined sensation of what may be called abnormal darkness—darker than common darkness—which lasts for about one-sixtieth of a second, and is followed by another interval of ordinary darkness.

(6) Finally, in about a fifth of a second after the extinction of the external light, there occurs another transient impression of luminosity, generally violet coloured, after which the uniformity of the darkness remains undisturbed.

No account has been taken of the comparatively feeble after-image, to which the phosphorescent trail before referred to is due, and which may last for two seconds or more.

In an addendum to the paper reference is made to the recent experiments of Dr. Carl Hess ("Pflüger's Archiv für Physiologie," vol. xlix. p. 190).

PARIS.

Academy of Sciences, August 27.—M. Lœwy in the chair.—On the variations of the apparent signs of lines and angles, in direct vision and in vision by movements of the eyes and head, by M. Ch. Henry. Formulæ and tables are given embodying the results of the consideration of a great number of cases and enabling apparent sizes to be calculated.—On the transformation of *équations canoniques* in the problem of three bodies, by M. Paul Vernier.—On the possibility of replacing the indeterminate problem given by the generalisation of Pascal's theorem by a determinate problem, by M. Paul Serret.—Researches on the movements of the solar atmosphere, by M. H. Deslandres. An examination of many photographs of spectra of the sun reveals interesting phenomena in connection with a bright line occurring within the wide dark lines H and K of calcium. This line may be resolved into two bright lines enclosing a dark line; the bright lines correspond to the lower layers of the chromosphere, while the dark line belongs to the higher layers. These bright lines often show dissymmetry, sometimes one and sometimes the other becoming the narrower. Spectra of the faculæ do not usually show this dissymmetry, but it is a common condition over the remainder of the surface, and is more pronounced near the equator than in the neighbourhood of the poles. Near spots the observed dissymmetry is often in the opposite direction on opposite sides, and the narrowing of the line is sometimes irregular. These phenomena can be explained on the hypothesis of a continual circulation of the sun's atmosphere, but it is worth noting that a less marked dissymmetry has been obtained in the calcium spectrum produced by the induction spark. Resemblances are pointed out between these phenomena and those observed in the spectrum of Nova Aurigæ.—A remarkable thunderstorm, by M. Ch. V. Zenger.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Fabrication de la Fonte: E. de Billy (Paris, Gauthier-Villars).—City and Guilds of London Institute, Programme of Technological Examinations, &c., Session 1894-95 (Whittaker).—Review of Mineral Production in India for 1893 (Calcutta).—Sach-und Orts-Verzeichnis zu den Mineralogischen und Geologischen Arbeiten von Gerhard vom Rath: W. Bruhns and K. Busz (Leipzig, Engelmann).—Katalog der Bibliothek der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher, Fünfte Liefg. Band 22: O. Grulich (Halle, Blochmann).—The Country Month by Month, September, Owen and Boulger (Bliss).

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